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THESIS

QUALITY ASSURANCE INITIATIVES FOR THE NAVY'S COMMERCIAL ACTIVITIES PROGRAM

by

Timothy Lee Ortel
and
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June 1983

Thesis Advisor: D. C. Boger

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operations has fostered the application of statistical quality assurance techniques for CA service contract administration. These are presented, as well as an overview of extrapolated deductions based on sampling techniques. Finally, improvements in organization staffing and structure are examined. The study recommends increased usage of statistical quality assurance, more comprehensive planning and budgeting of inspection resources, and the formation of centralized CA contract administration organizations at the field activity level.

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Quality Assurance Initiatives for the Navy's Commercial Activities Program

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ABSTRACT

The implementation of OMB Circular A-76 to secure cost savings by federal agencies has resulted in increased contracting out of Commercial Activities (CA) formerly performed by the government workforce. This thesis examines the background of the A-76 policy and describes its requirements. Implementation of the CA program, particularly by NAVFAC, is investigated in detail. An A-76 emphasis on cost effective government operations has fostered the application of statistical quality assurance techniques for CA service contract administration. These are presented, as well as an overview of extrapolated deductions based on sampling techniques. Finally, improvements in organization staffing and structure are examined. The study recommends increased usage of statistical quality assurance, more comprehensive planning and budgeting of inspection resources, and the formation of centralized CA contract administration organizations at the field activity level.

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I. INTRODUCTION

A. GENERAL COMMENTS

The Office of Management and Budget (OMB) Circular No. A-76 requires federal agencies to inventory and review all of their Commercial Activities (CA). A Commercial Activity is defined as one which is managed and operated either by the government or by a private firm and which provides a product or service to a federal agency. Unless the activity is an inherently governmental function which is required to be retained in-house, it must be subjected to a rigorous cost comparison to determine the most economical way to perform the work. If the cost study shows that it is cheaper for the government to perform the work, in-house resources will be used. However, if it is more economical for the private sector to provide the product or services, the function is contracted out.

In 1981, the federal government spent $32.5 billion on services of a commercial nature, including maintenance of equipment, military base operations, and facility support such as housekeeping, security, and food services. [Ref. 1]. Currently, an estimated 400,000 federal employees perform in-house CA functions valued at $20 billion. As federal agencies move to comply with A-76 policy, the level of contracting out of CA functions is expected to grow tremendously. It is imperative that this implementation be systematic and well thought out in order to achieve both maximum economy and efficiency of operations. [Ref. 2]

B. STUDY OBJECTIVES

The principal objectives of this research report are to examine the application of statistical quality control to CA service contracts and evaluate improved designs for contract administration organizations.

C. SCOPE AND ASSUMPTIONS

Although the Commercial Activities policy is applicable to all federal agencies, this study will focus on the Department of Defense (DOD), with particular emphasis on the Navy in general and the Naval Facilities Engineering Command (NAVFAC) in particular. It is assumed that the reader is familiar with the acquisition process within the Department of Defense.

D. RESEARCH METHODOLOGY

An initial literature search was conducted to review pertinent instructions, regulations, policy guidance, industrial literature, and reports applicable to A-76 implementation. Interviews and discussions were conducted during onsite visits with personnel at the following organizations:

1. Naval Supply Center, Oakland, CA;
2. Public Works Center, San Francisco, CA;
3. Western Division, Naval Facilities Engineering Command, San Bruno, CA;
4. Naval Weapons Station, China Lake, CA;
5. Public Works Center, San Diego, CA;
6. Civil Engineer Corps Officer School, Port Hueneme, CA;
7. McClellan Air Force Base, Sacramento, CA;
8. Travis Air Force Base, Fairfield, CA;

9. Public Works Department, Naval Shipyard Long Beach, CA; and
10. Public Works Department, Naval Postgraduate School, Monterey, CA.

Additional telephonic conversations were held with personnel in the following headquarters organizations:

1. Naval Material Command, Washington, D.C.;
2. Naval Facilities Engineering Command, Alexandria, VA;
3. Naval Supply Systems Command, Washington, D.C.;
4. Office of Federal Procurement Policy, Washington, D.C.; and
5. National Aeronautics and Space Administration, Washington, D. C.

E. THESIS ORGANIZATION

Chapter I defines the Commercial Activities policy and presents the authors' objectives and methodology. Chapter II discusses the scope, requirements, and implementation of A-76. Chapter III identifies key issues in CA conversions, while Chapter IV examines the application of statistical quality control to CA contracts. The next two chapters address the planning, budgeting and design of the service contract administration organization. Finally, Chapter VII presents the study's recommendations for improvements in CA contract conversions.

II. COMMERCIAL ACTIVITIES POLICY

A. DEVELOPMENT OF THE POLICY

1. Executive Branch

The government's policy for not competing with the private sector was first established during President Eisenhower's administration. In 1955, the Bureau of the Budget (BOB), the predecessor of the Office of Management and Budget (OMB), published Bulletin Number 55-4 which stated:

> It is the general policy of the administration that the Federal Government will not start or carry on any commercial activity to provide a service or product for its own use if such a product or service can be produced from private enterprise through ordinary business channels. Exceptions to this policy shall be made by the head of agency only where it is clearly demonstrated in each case that it is not in the public interest to procure such products or services from private enterprise. [Ref. 3]

In 1966 the first Circular No. A-76 was issued by BOB and it represented a major change in previous policy statements concerning contracting out. A-76 reaffirmed "the Government's general policy of relying on the private enterprise system to supply its needs" [Ref. 4] but it also recognized some instances where "it is in the national interest for the Government to provide directly the products and services it uses." [Ref. 4]

The basic policy underwent another major change with the issuance of OMB Circular A-76 (revised) dated 29 March 1979. Unlike the previous statements which only stressed government reliance on private enterprise, the new policy has three guiding principles. [Ref. 5]

a. Rely on the Private Sector. The Government's business is not to be in business. Where private sources are available, they should be looked to first to provide the commercial or industrial goods and services needed by the Government to act on the public's behalf.

b. Retain Certain Governmental Functions In-House. Certain functions are inherently governmental in nature, being so intimately related to the public interest as to mandate performance by Federal employees.

c. Aim for Economy; Cost Comparisons. When private performance is feasible and no overriding factors require in-house performance, the American people deserve and expect the most economical performance and, therefore, rigorous comparison of contract costs versus in-house costs should be used, when appropriate, to decide how the work will be done.

To support the new emphasis on the economy of government in-house performance compared to private contractor performance, a Cost Comparison Handbook was issued as a supplement to A-76. One year later, in April 1980, the Department of Defense (DOD) issued its own Cost Comparison Handbook (DOD 4100.33-H) to provide even more detailed instructions to DOD activities. The intended purpose of these handbooks is to provide uniform procedures for conducting the cost comparisons and to improve their accuracy and validity. Some general ground rules include: [Ref. 5]

a) Both the government and commercial costs must be based on the same scope of work and the same level of performance.
b) Standard cost factors will be based on the Cost Comparison Handbook.
c) Full costs are to be used to the maximum extent practical.
d) For workloads of a continuing nature, prepriced or renewable options should be requested from the contractor to minimize buy-ins.
e) Services costing under $100,000 annually should be contracted out without a cost study unless the commercial price is unreasonable.

f) The cost comparison will use a rate of 10 percent per annum as the opportunity cost of investments and of the net proceeds from the potential sale of capital assets.

2. Legislative Branch

As a result of the increased emphasis on contracting out, Congress has repeatedly expressed its concern about the implementation of the A-76 policy. In fiscal year 1978 (FY 78), Congress placed a one year moratorium on virtually all contracting out of A-76 functions if such a conversion would displace a Government employee. [Ref. 6] At the start of FY 83, Congress instituted a six month moratorium on certain A-76 functions. Although the most recent ban exempted studies on grounds maintenance, refuse collection, food services, base transportation, laundry and custodial functions, it prohibited all other contracting out studies. In addition, it prevented the conversion of contracts for all non-exempt A-76 studies completed but not yet awarded. [Ref. 7]

There are also two Public Laws which guide DOD's decision to convert. The overall management of DOD personnel resources is contained in DOD's Appropriation Authorization Act, 1975, excerpts of which are provided in Appendix A. This Act requires that DOD "use the least costly form of manpower that is consistent with military requirements and other needs of the Department of Defense". [Ref. 8] Sections of the DOD Authorization Act of 1981 providing further restrictions are also included in Appendix A. The Act states that functions cannot be contracted out to circumvent any civilian personnel ceiling, or unless the Secretary of Defense provides Congress specific notification, certifications, and reports in a timely manner.

[Ref. 9] These two provisions are considered to be permanent laws which will remain in effect until changed by subsequent legislation.

E. SCOPE OF A-76

1. Exclusions

The provisions of OMB Circular A-76 do not apply to the following categories and situations: [Ref. 5]

a) For contracting out of personal services that would result in an employer-employee relationship.
b) For major system acquisitions governed by OMB Circular A-109.
c) For Contractor Support Services which include consulting services, studies and analysis, and professional and management support services.
d) Whenever implementation would be contrary to law or inconsistent with the terms of any treaty or international agreement.
e) When the activity is performed outside the United States, its territories, or possessions.
f) When products and services are obtained from other federal agencies which are authorized or required by law to furnish them.
g) In times of declared war or military mobilization.

2. Inherently Governmental Functions

In addition, A-76 recognizes that inherently governmental functions must be performed in-house. These governmental functions fall into three main categories. The first category is the discretionary exercise of Government authority. This includes: [Ref. 5]

a) investigations, prosecutions and other judicial functions;
b) management of government programs requiring value judgements such as directing the national defense;
c) management and direction of the armed services;
d) conducting of foreign relations;
e) selection of program priorities;
f) direction of federal employees;
g) regulation of natural resources such as the use of space, oceans, and inland waterways;
h) direction of intelligence and counter-intelligence operations; and
i) regulation of industry and commerce.

The second category of an inherently governmental function involves monetary transactions and entitlements such as benefit programs; tax collection and revenue disbursements; control of financial accounts and the administration of public trusts. The last type of government function is the conduct of research and development at test facilities and the operation and maintenance support of laboratories, test ranges, test aircraft and ships. [Ref. 5]

3. Commercial Activities Subject to A-76

If a service activity is not specifically excluded from OMB A-76 as previously discussed in Section B1 of this chapter, and is not an inherently governmental function as defined in Section B2, then it is classified as a Commercial Activity. Attachment A to OMB A-76 provides approximately one hundred examples of Commercial Activities for fifteen different service categories. Such Commercial Activities may be operated and managed either by the government agency or a private commercial business.

4. Government Operation of a Commercial Activity

In-house performance of Commercial Activities cannot be justified solely on the basis that an activity supports or involves a classified program, or is part of an agency's basic mission, or that there is a possibility of a strike by contract employees. Government operation of a Commercial Activity can only be authorized under one of the following conditions: [Ref. 5]

a) No Satisfactory Commercial Source Is Available. Government operation is permitted whenever it can be documented that either:
  i) There is no private commercial source capable of providing the needed service, or
  ii) That the use of a private source would cause unacceptable delay or disruption of an essential program. The required documentation must be detailed in terms of cost, time, and performance measures. The disruption must be of a lasting nature and not just temporary.

b) National Defense.
  i) Government operation by military personnel is permitted whenever:
    1. The personnel are utilized in or subject to deployment in a direct combat or combat service support role.
    2. The activity is essential for exclusively military training.
    3. The activity is required to provide appropriate work assignments for career progression or a rotation base for overseas or sea to shore assignments.
  ii) Government operation of a depot or intermediate level maintenance facility may be justified to

ensure a ready and controlled source of technical competence and resources necessary to meet military contingencies.

c) Lower Cost. If none of the preceeding conditions can be met, government operation of a Commercial Activity can only be authorized when a comparative cost analysis, performed in accordance with A-76 and the Cost Comparison Handbook, shows that in-house operation has a lower total cost than if it were obtained from a qualified private source.

C. REQUIREMENTS OF A-76

1. Inventory of Commercial Activity Functions

OMB Circular A-76 required each agency to compile and update annually a complete inventory of all Commercial Activities subject to its provisions. The initial DOD inventory was completed in August 1980 and is summarized in Figure 2.1. [Ref. 10]

SERVICE	NUMBER OF CA FUNCTIONS	ANNUAL OPERATING COSTS (BILLION $)	MAN-YEARS (THOUSANDS)
ARMY	2,941	7.1	133
NAVY/MARINE	6,268	6.1	278
AIR FORCE	5,624	3.6	260
OTHER DOD	454	.2	18
TOTAL	15,287	17.0	689

Figure 2.1 DOD Inventory of CA Functions.

2. Management Review

DOD Instruction 4100.33 requires that a complete review of all CA functions be completed during FY 80 through FY 84. Subsequent reviews are required at least once every five years. In the event that the circumstances supporting the initial approval are not subject to change, then subsequent reviews may be waived by the Assistant Secretary of Defense (Manpower, Reserve Affairs, and Logistics).

The purpose of the review is to determine whether the present method of performance should be continued or if the function should be designated for a cost comparison analysis for possible change in method of performance. In making this determination, the criterion specified in A-76 and explained previously in this chapter are used. If the function is presently contracted, a rough estimate of the cost to perform the work in-house is prepared. If this estimated in-house cost is not less than contract performance by 10 percent of personnel cost and 25 percent of cost of ownership of equipment and facilities, then the function remains contracted out. However, if the likelihood exists that in-house performance would meet the cost differential criteria, formal cost comparison analysis must be performed to determine the cheaper method.

3. Development of Statement of Work

The preparation of the Statement of Work (SOW) is one of the most critical steps in the effective implementation of the A-76 policy. Its design will directly impact the nature of the solicitations, the cost comparison process and subsequent performance either by in-house personnel or by contractor employees. The SOW must establish the government's actual minimum requirements for performing the service. These standards are the same regardless of whether

the work is performed by the government or by the contractor.

The SOW constitutes the specifications for the contract. It should be sufficiently comprehensive, expressing all requirements in a clear, unambiguous and concise manner. It should describe all duties, tasks, responsibilities, and frequencies of performance. The SOW should be performance oriented and specify what is to be done without prescribing how it must be done. If specific procedures are required, the government bears the risk that compliance will result in unacceptable performance. However, if the SOW establishes the minimum acceptable quality level (AQL), then the contractor assumes full legal liability for meeting this standard.

Along with the SOW, a quality assurance plan is required [Ref. 11]. This plan sets the surveillance requirements and procedures for the government's quality assurance evaluators. The quality assurance plan helps to ensure that adequate performance is achieved and establishes the mechanisms for the administration of the service. Chapters IV and V will examine these issues in greater detail.

4. Prepare and Audit In-House Estimate

The DOD Authorization Act, 1981 requires that government in-house estimates be based on the "most efficient and cost effective organization for performance". [Ref. 9]. DOD Instruction 4100.33H directs that : [Ref. 12]

> Each agency should ensure that Government operations are organized and staffed for the most efficient performance. To the extent practicable and in accordance with agency manpower and personnel regulations, agencies should precede reviews under this circular with internal management reviews and reorganizations for accomplishing the work more efficiently, when feasible.

The activity is not required to achieve this most efficient organization (MEO) prior to a cost comparison study but it must use the MEO as the basis for the government in-house estimate.

After the in-house estimate is prepared, based on the established Statement of Work and using the most efficient organization, it is required to be audited. The audit is performed by an independent audit agency, normally the Naval Area Audit Service, and must be started 120 days prior to bid opening. [Ref. 13] In addition to ensuring proper compliance with A-76 and the Cost Comparison Handbook, the Audit Service reviews and approves the proposed SOW and the MEO.

5. Solicitation and Evaluation of Contractor Proposals

Once the in-house estimate has been approved, firm bids or proposals will be solicited. Although competitive negotiations on a firm fixed price basis are the preferred method of contracting, formal advertising and other pricing arrangements may be approved in rare instances. [Ref. 14] After the contracting officer opens the bids or completes negotiations, he determines the lowest acceptable contract price of the responsive and responsible bidders.

6. Cost Comparison

If the lowest acceptable contract price exceeds the total in-house cost, then the performance by the government is assumed to be cheaper and the cost comparison process is complete. When the contract price is less than the in-house estimate, further adjustments are required to evaluate the impact of the two alternatives on the overall cost of government operations.

There are two adjustments made to the in-house bid. First, the cost of capital for assets that will be used for in-house performance must be added. Second, any one time cost associated with a new start where the function is not presently performed in-house must also be included.

The contract price must also be adjusted for several factors. A cost of capital charge may be added if government assets are required to assure contractor performance. Conversion costs are added to reflect the one time costs incurred by the government in shifting operations from in-house to contract. When contracting out would result in a reduction of the present level of capacity, the additional amount of overhead which must be absorbed by the remaining activities is added to the contract cost. Finally, the potential federal income tax revenue which would be paid by the contractor is deducted from his contract price.

After all adjustments have been made, an existing in-house function is not converted unless the projected contract price is lower than the government estimate by at least 10 percent of the in-house personnel related cost. This differential is included to account for the possible loss of production, the temporary decrease in efficiency and effectiveness, and other unpredictable risks that result from contract conversion. [Ref. 12]

7. Decision and Appeal Process

Upon completion of the cost comparison, a recommendation is made to either award the contract or to perform the function in-house. The recommendation, along with the cost comparison forms are forwarded to the approving authority for review and approval. Once approved, the results of the cost study are announced and the detailed analysis is made available to the public. If no significant discrepancies are identified or an appeal lodged within 5

working days (which may be extended by the contracting officer up to 15 days for complex decisions), the contracting officer will either award the contract or cancel the solicitation. In the event the function is to be performed in-house, implementation of the MEO must be initiated within 30 days and be completed within one year. [Ref. 15]

D. IMPLEMENTATION OF A-76

Currently an estimated 400,000 federal government employees perform commercial activities valued at $20 billion annually. Of this amount, only $6 billion are eligible for cost studies; the other $14 billion worth are exempt from A-76 for reasons of national defense. Although progress is accelerating rapidly, to date, only a small portion of the eligible functions have received a cost comparison.The Office of Federal Procurement Policy (OFPP) estimates that a savings of over $5 billion could be achieved over the next five years if these cost studies were completed. [Ref. 2]

Since 1979, DOD has saved approximately $140 million per year as a result of CA studies. In addition, an average of 4,000 personnel billets have been converted to contract in each of the last four years. [Ref. 2] Data compiled in January 1982, showed that 60 percent of the functions reviewed shifted to contract and the average costs dropped 19 percent. These reductions were widely distributed however, with two-fifths showing greater than 30 percent savings, another two-fifths having savings between 11 and 25 percent, while the remainder saved 10 percent or less. [Ref. 1]

In FY 82, the Navy had its best year to date in implementing the A-76 program. A total of 252 cost studies were completed ; more than twice the number for the previous three year period. Of the 5,487 civilian man-years studied, 2,060 were contracted out resulting in a savings to the government exceeding $15.9 million. The remaining functions that were retained in-house netted a cost avoidance exceeding $17 million. [Ref. 16]

As of 1 March 1983, the Navy has identified 53,457 personnel billets as candidates for CA studies. The total percentage under NAVFAC's functional/contractual responsibility was 54 percent. Although NAVFAC still has the highest percentage in the Navy, its share has decreased from FY 82 when it was as high as 70 percent. NAVFAC took an early lead in CA contracting for the Navy by providing standardized Performance Work Statements to its field activities. Of all the NAVFAC functions studied, the four areas of transportation, grounds care, building maintenance, and janitorial services comprise 82 percent of the total. [Ref. 17]

III. CONTRACT CONVERSION ISSUES

A. PACKAGING OF CA FUNCTIONS

In implementing the A-76 policy there are several important contract conversion issues which must be addressed. One issue concerns the different methods in which Commercial Activities functions can be reviewed and cost compared. For example, a single function from the activity's inventory , such as bus services, can be studied individually. Alternatively, several functions may be combined into a package such as vehicle operations and maintenance. When most, if not all, functions are consolidated by an activity, a total Base Operating Support (BOS) package is formed.

A multi-function approach offers many advantages over a single function one. It facilitates implementation of A-76 because it reduces the number of cost comparisons. As a result, it is a very appealing option to those commands who are under intense pressure to quickly contract out. Recent Navy experience has shown that when smaller functions are cost compared under A-76 on a single function basis, they are extremely likely to remain in-house. However, when these same functions are consolidated into a multi-function package they are far more likely to be contracted out. [Ref. 16]

The nature of service contracting is such that manual labor alone is insufficient to ensure satisfactory performance. What is needed is an effective management organization that can get the job done properly. A multi-function contract increases this requirement and because of its greater dollar value, attracts larger firms that have increased management expertise. If the functions are

complex or time constrained it may require the vast resources of the larger firm. Consolidation of functions can also lead to greater economies of scale and more efficient use of personnel and material.

The entire process of contract administration is much easier when dealing with a single large contractor rather than many small ones. The command does not have to contend with many differing company policies, procedures, and personnel. There is a higher probability for satisfactory rework because whenever a problem is identified, only a single point of contact need be reached. In addition, there are fewer opportunities for contractor to contractor finger-pointing with multi-function contracts.

B. SMALL BUSINESS CONSIDERATIONS

Multi-function packaging, while of great value in implementing OMB Circular A-76, comes in conflict with another national policy; the Small and Disadvantaged Business Utilization (SADBU) Program. Public Law 95-507, signed on 24 October 1978, provides the legal framework for the SADBU Program. Section 21 of this law states: [Ref. 18]

> It is the policy of the United States that small business concerns and small business concerns owned and controlled by socially and economically disadvantaged individuals, shall have the maximum practicable opportunity to participate in the performance of contracts let by any Federal Agency.

A small business concern is one that is independently owned and operated, and qualifies under guidelines established by the Small Business Administration (SBA) with regard to number of employees and annual receipts. A small disadvantaged business is one owned and operated by a minority (Black, Hispanic, American Indian, etc.). In order to ensure fair opportunity to participate in government

contracts, certain classes of procurements have been set aside for the exclusive participation of small business or have been granted 8(a) set asides for small disadvantaged businesses.

Circular A-76 requires that any contracts which have been awarded under authorized set-aside programs will not be reviewed for possible in-house performance. It also directs that functions previously performed in-house that are suitable for a set aside program be awarded without a cost comparison. On the other hand, A-76 states in-house activities in excess of $100,000 annually will not be set aside unless the conversion is justified by a cost analysis. This last statement has been interpreted to allow unrestricted award of multi-function contracts even though the individual functions, if awarded separately, would require being set aside to small business.

On 16 March 1982, Congressman Joseph Addabbo (D-NY) expressed his concern to Secretary of the Navy John Lehman, that consolidation of base support services under BOS contracts would devastate the Navy's SADBU Program. Congressman Addabbo claimed that many of the functions being consolidated were traditionally performed by small business. He maintained that because of the contract's large size and complexity, small business could no longer become prime contractors, regardless of their prior performance. He further contended that large primes will "usually choose not to subcontract to small or small disadvantaged firms for a particular service function." [Ref. 19] The Congressman concluded by requesting the Navy stop all consolidations.

In a follow-up letter dated 23 April 1982, Congressman Addabbo chided Secretary Lehman for not sending him a substantive reply to his original request. He also charged that the Navy had accelerated its efforts to exclude small

and minority business from service contracts. As evidence, he cited the $6.9 million BOS contract awarded at Naval Weapons Center, China Lake, California on 18 April 1982. He also identified six other BOS solicitations that were recently released by other Naval activities. In closing, Congressman Addabbo renewed his request to halt all further consolidations of CA functions. [Ref. 20]

In his response, Secretary Lehman stated, [Ref. 21]

> It is my strong belief that consolidated contracting can be a cost effective strategy often fostering a more efficient use of scarce acquisition resources. However, I also believe that consolidations must be undertaken with a keen awareness of the objectives of the small business program.

Secretary Lehman maintained that small business has had considerable success in capturing multi-function contracts. In the China Lake award, he explained that eight of the fifteen functions, representing 50 percent of the contract's value, were subcontracted to small business. Finally the Secretary promised that a significant portion of future consolidated contracts would be awarded to SADBU firms either in total or in part via subcontracting.

On 24 May 1982, Secretary Lehman sent a memorandum to the Chief of Naval Operations (CNO) outlining the Navy's new policy on consolidated service contracting. It makes three major points: [Ref. 22]

a) Consolidation of existing small business contracts shall only be considered when there is a reasonable expectation that it will result in an award to small business. In the event that such an award is not accomplished, individual function contracting must be reinstated.

b) Functions which are currently being performed under 8(a) contracts will not be considered for consolidation unless consented to by the SBA.

c) Contracting out of current in-house CA functions shall be done giving the SADBU Program careful consideration early in the planning stages. In those instances where small business participation is determined not to be in the best interest of the Navy, supporting justification must be forwarded to CNO (OP 443) prior to solicitation.

One week later, on 1 June 1982, Deputy Secretary of Defense Frank Carlucci promulgated the DOD policy that is still in effect today. The policy directed that any functions currently performed by small business shall not be considered for consolidation. In addition, the Carlucci memo stated that : [Ref. 23]

> Future solicitations, unless there are overriding national security considerations, will be packaged so as not to preclude performance by small and small disadvantaged concerns *as prime* contractors.

Although the issue appeared to be resolved, it has again surfaced with the Office of Federal Procurement Policy proposed revision to A-76 that is currently being considered. This proposal would direct that consideration be given to consolidating CA functions into a single statement of work for cost comparison and potential contract. While admitting that consolidation may reduce prime contract opportunities for SADBU concerns, it only directs a reasonable balance be maintained between consolidations and single function awards to small business. [Ref. 15]

In addition to OFPP's recent support of multi-function packaging, the new Deputy Secretary of Defense, Paul Thayer has stated that he intends to change the DOD consolidation policy issued by his predessor, Frank Carlucci. Recognizing

that the current policy all but precludes multi-function CA contracts, Thayer favors an approach which encourages consolidations geared to large firms while simultaneously providing subcontracts to SADBU concerns. [Ref. 2] Both the OFPP revision to A-76 and the new DOD policy on consolidation are expected to be promulgated within the next several months [Ref. 24].

Approximately 3000 Navy CA functions involve fewer than 10 civilian personnel man-years. Even when consolidated into small multi-function contracts, many will still be within the capability of small businesses. Of the 252 cost studies conducted in FY 82, twenty were greater than fifty man-years and of these, only five were over one hundred man-years of effort. [Ref. 16] Although 65 percent of the studies were restricted to small business, these set asides resulted in fewer contract awards. While 75 percent of the civilian man-years in the unrestricted solicitations were contracted out, only 37 percent of the small business set asides were awarded. [Ref. 25] These results clearly demonstrate that the larger unrestricted solicitations are more competitive with the government and lead to greater conversions to contract.

It would appear that the Navy cannot achieve the reasonable balance sought by OFPP unless it is allowed greater latitude in consolidating CA functions. As additional functions are subjected to CA cost studies, an increasing percentage will be more complex, critical, and efficient since the easier and less efficient functions will already be contracted out. It is therefore predictable that individual functions and those restricted to small business will have even less success than at present in winning a contract award. Thus a total reliance on single function packaging will not only be detrimental to small business but will also severely handicap the A-76 aim for economy and productivity.

C. QUALITY ASSURANCE OF CA CONTRACTS

When the federal government purchases items or services under a contract, it assumes the responsibility for ensuring that such items or services conform to stated contractual requirements. Two concurrent processes commence at contract award which influence satisfactory quality.

The contractor establishes a quality control program whereby management control of materials or services is exercised for the purpose of prevention of defects. In government contracts, the contractor assumes the responsibility for the execution of the quality control process. [Ref. 26]

At the same time , a government contract inspection organization administers a quality assurance process. Quality assurance is a planned and systematic approach of observing service performance to provide adequate confidence that the items or services conform to established technical requirements. The quality assurance process verifies the required quality of delivered items or services prior to their acceptance.

Under current A-76 policy, two key documents are prepared during the pre-solicitation phase that influence the follow-on quality control and assurance processes. These are known as a statement of work and quality assurance plan. The performance-oriented statement of work describes the minimum required level of services that will be expected of the successful contractor. The quality assurance plan states the procedures that will be used to check and verify contractor performance.

Prior to the 1979 revision of A-76, solicitations frequently used design specifications which established precise measurements, tolerances, or quality control requirements for the contractor. Other detailed information was provided when deemed necessary. These specifications

were primarily intended to obtain standardization of delivered items or services. In CA service contracting, such specifications often proved to be unwieldy and ineffective. Standardization was not always a suitable objective for the service contract process given a wide diversity in contractor skills and the character of operations at different Navy activities. The government assumed substantial risk with this method in that it guaranteed acceptable results as long as the specifications were followed.

On 26 January 1982, an OMB memorandum directed that the Office of Federal Procurement Policy Pamphlet No. 4 be designated as Supplement No. 2 to Circular A-76. It further required that both work statements and quality assurance plans for CA functions be written in accordance with this new supplement . [Ref. 27] The OFPP Pamphlet embraces the widespread utilization of performance-oriented work statements instead of detailed, exacting design specifications . The contractor is clearly and precisely told what is required but not how he must do it. This allows a contractor more flexibility in performing the work. An objectively defined end product facilitates the contractor's quality control and the government's quality assurance effort. The quality assurance plan gives the government inspector a detailed, written plan which allows him to accurately assess the contractor's performance.

The statement of work design encumbers several review steps and processes. First, functional areas subject to cost study must be completely defined. All resource inputs, work processes, and production outputs required for successful performance of the job function must be identified and integrated. After this, a job analysis process occurs in which the structure of the organization is designed, an itemized listing of work elements for the function is enumerated, and standards of performance for each work element are set. In

addition, resources to accomplish work input are determined, performance indicators are listed, and deviation from acceptable standards are specified. [Ref. 28] When the job analysis is complete, the essential rudiments of a contractual statement of work will be formulated. Functional area managers then consult with contract specialists and industrial engineers to complete the contract package.

The Air Force and Navy have promulgated regulations which implement the precepts of OFPP No. 4. Over the past three years, both have issued standardized statements of work (SOW's) or performance work statements (PWS's) which pertain to specific CA functions such as refuse collection, grounds maintenance, or any other areas listed in A-76 inventories. A field activity performing A-76 cost studies will utilize these PWS's and tailor them to incorporate the special local requirements. Approximately twenty PWS's have been written for Navy Public Works commercial functions.

Standardized quality assurance plans have also been prepared for each statement of work and can be tailored by local activities. These state the methods that will be used in inspecting all contract requirements. The Naval Facilities Engineering Command identifies five methods of surveillance: [Ref. 28]

a) One hundred percent surveillance involves inspection of each occurence of contract output. It is expensive, time consuming, and not 100 percent reliable.

b) Planned sampling allows part of the contract output to be evaluated. It is subjective, and generally useful only when certain items of work are very important.

c) Random sampling uses statistical techniques to sample a portion of contract outputs. Each item has an equal chance of being evaluated, eliminating inspection bias.

d) Unscheduled inspections are impromptu spot checks of the contractor's performance.

e) Validated complaints result when customers express dissatisfaction with contractor performance. Although complaints may not be used in lieu of the other methods, they can be used to verify results of other inspection methods, and make payment deductions.

The method of inspection is tempered by the various types and frequencies of work. Repetitive, frequent performance may be best suited for planned and random inspection methods while infrequent, critical work items may require 100 percent surveillance . Once a method is chosen, inspection schedules are created for each month of contract performance . Evaluation worksheets listing each work item are prepared, inspections are conducted, and results are recorded. Good performance is rewarded while poor performance is required to be corrected.

When a contract solicitation is issued, the statement of work and other mandatory (boilerplate) provisions are assembled and distributed to prospective bidders. The Air Force has adopted the practice of distributing its quality assurance plans (less actual inspection schedules) to each bidder in an attempt to alert them of the contract's quality assurance standards . One key requirement of this entire package is clarity, precise wording, lack of ambiguity, and conciseness. Lofty and technical wording tends to be confusing and must be avoided.

The authors observed that in several instances, more attention is given to preparation of the statements of work than to quality assurance plans. This is understandable, since many DOD activities are rushing to comply with the A-76 requirement to complete cost studies by FY 84. In spite of this time constraint, it would be counterproductive for

an activity to move towards implementation of widespread CA service contracting without a specific and definitized plan for quality assurance.

The next chapters discuss initiatives in effective surveillance methods and properly structured inspection organizations. A well designed quality assurance program will result in the optimum use of scarce inspection resources and will help ensure adequate performance by CA service contractors.

IV. STATISTICAL QUALITY ASSURANCE TECHNIQUES FOR A-76 CONTRACTS

A. INTRODUCTION

During A-76 cost studies, three documents are prepared which play a key role in the Commercial Activities (CA) contract process. The first is a contractual statement of work which defines minimum requirements for services ordered in the contract. The second, a quality assurance plan which is designed and integrated with the statement of work, summarizes those schedules and techniques that will be used by the government to verify contractor performance. A third essential document, the cost estimate, reflects the most effective and efficient government employee performance of the function being studied.

One prime objective of A-76 is cost effective mission performance by federal agencies. This is demonstrated by comparing the cost estimate of government employee performance to prices offered by competing contractors who participate in A-76 firm bid procedures. The low offeror gains the right (usually) to perform the function.

This emphasis on cost effective performance of government operations is reflected in that guidance which describes the preparation of A-76 CA quality assurance plans. DOD publications describing the design and implementation of quality assurance programs are :

a) Air Force Regulation 400-28 of September 1979;

b) Office of Federal Procurement Policy Pamphlet Number 4 of October 1980; and

c) Naval Facilities Engineering Command Manual MO-327 of November 1982.

Each of these publications calls for development of cost-effective quality assurance programs by each field activity to provide reliable assessment of service contract performance. Cost-effective surveillance does connote an inspection system being created at the least possible cost; more appropriately, the important facet of such quality assurance is to utilize existing or new inspection systems and resources in a reliable, dynamic fashion to gain the best determination of contractor performance under CA contracts. It should have the capability to be easily modified when CA contract workloads increase.

The Naval Facilities Engineering Command asserts the importance of properly designed quality assurance programs, contrasting old and new inspection plan design philosophies: [Ref. 28]

> The Navy's traditional approach to surveillance of service contracts, often a hit or miss affair with no written plan, has not provided adequate quality assurance.... The method of surveillance which is claimed to be used most frequently is 100 percent inspection. In reality, however, such inspection is often less than total inspection since it is very costly and not always feasible. Further, traditional surveillance methods have usually focused on the work process (adherence to specified steps and frequencies) rather than on the quality of contract outputs. The net result does not assure quality performance.... NAVFAC's new quality assurance approach, based on a written plan, is keyed to performance oriented specifications. It focuses on the quality of the product delivered by the contractor and not on the steps taken or procedures used to provide that quality.... It includes appropriate use of preplanned inspections, validation of customer complaints, and unscheduled inspections. It provides a structured appproach to surveillance that permits management control of quality assurance.

The contractor administers quality control over performance to ensure that a minimum level of service quality is maintained. Quality is top management's requirements for service outputs which stress that these be provided at a cost less than their value. Performance processes must be conducted with efficiency and effectiveness. Control refers

to procedures of top management used to determine that service activities are being carried out in a manner that was established by prior planning and goal setting.

Quality control is aimed at the prevention of unsatisfactory performance of CA contract services. Contractor programs focus on developing employee self motivation to render acceptable performance of service. Quality control leads to increased profits for the contractor and high levels of customer satisfaction, and facilitates increased employee productivity in work performance. [Ref. 29]

Circular A-76 emphasizes effective contractor quality control and government quality assurance by embracing a new type of surveillance procedure known as random sampling inspection. Traditional planned inspection and 100 percent inspection systems are being replaced by those having a statistical basis. Statistical sampling techniques increase the objectivity of government quality assurance since each item of service has an equal chance of being inspected. The number of government inspectors required for the surveillance process is reduced, resulting in less inspection costs.

B. THE EVOLUTION OF STATISTICAL QUALITY CONTROL

A brief examination of the definition and history of statistical quality control will be described. A definition of statistical quality control (SQC) follows: [Ref. 30]

> Statistical quality control is the employment of statistical principles and methods which have been developed to assess the magnitude of 'chance cause variation' and to detect 'assignable cause variation.' Variation due to 'chance causes' is inevitable while variation due to 'assignable causes' can usually be detected and corrected by appropriate methods. Statistical quality control philosophy is the early detection of assignable causes so that product quality may be controlled at the desired level with a minimum of rejects.

Assignable causes of variation are due to differences in machines, workers, materials, and either their composition or relationship to each other over time [Ref. 31].

SQC processes contribute to economical achievements of product quality by applying a body of theory dealing with laws of large numbers and probabilities to various industrial and service processes. These originated in 1654 when Pascal, a French philospher and mathematician, teamed up with Pierre Fermat to develop the theory of probability. [Ref. 30]

Until the 1920's, most semblances of SQC were associated with measures of central tendency, or averages. Increasing study at this time was devoted to the effect of standard deviations on control processes, and led to the foundations of modern statistical quality control. [Ref. 31]

Walter Shewhart of Bell Telephone Laboratories developed the first SQC model, known as the quality control chart. It was used to measure product quality variations by both the Bell system and by Western Electric Company, and was augmented by statistical sampling techniques of H. F. Dodge and H. G. Romig. [Ref. 32]

Widespread evolution of SQC application techniques occurred in World War II due to the need to minimize production scrap losses. Government agencies developed training courses for those personnel in industry who inspected product or service outputs. After World War II, American industry further developed SQC techniques, which were adopted in European and Asian countries as well. SQC became an underlying basis for many industrial productivity improvements and is still utilized extensively, as evidenced in modern Japanese industries. [Ref. 32]

Previous discussion may lead one to believe that SQC techniques were designed primarily for manufacturing applications, but these are equally valid for non-manufacturing

types of techniques. The following instances illustrate representative applications: [Ref. 31]

a) SQC was used by the Census Bureau to control clerical accuracy;
b) Aldens Inc., a mail order business, utilized control charts to establish accuracy in customer billings;
c) The Illinois Bell Telephone Company used SQC techniques to assess clerical accuracy in the accounting department;
d) The Standard Register Company used sampling plans to control accuracy of sales invoices;
e) United Air Lines used control charts to improve accuracy in customer bookings;
f) Statistical control techniques have been used successfully in the health industry [Ref. 33] ; and
g) Statistical quality control techniques have been used in highway and airport pavement construction [Ref. 34].

Based on the preceding observations, it is reasonable to apply statistical sampling techniques to CA service contract surveillance programs. Such techniques have been utilized by the Air Force in its A-76 contract conversions. Procedures for applying these techniques are stated in Air Force Regulation AFR 400-28.

This regulation incorporates a statistical sampling model known as acceptance sampling by attributes. This model is more fully described in Department of Defense Military Standard 105D of 28 April 1963 (MIL-STD-105D). The standard has been used successfully by defense industries since its original formulation, and its concepts form the basis for worldwide acceptance sampling standards. MIL-STD-105D can be used to inspect the following: [Ref. 35]

a) End items;
b) Components and raw materials;

c) Operations;
d) Materials in process;
e) Supplies in storage;
f) Maintenance operations;
g) Data or records; and
h) Administrative procedures.

This list is not exhaustive. The text of MIL-STD-105D is presented in Appendix B. Prerequisite conditions for successful use of SQC techniques are that operations be repetitive, independent, functional, and affected by as few outside factors as possible [Ref. 31]. CA service contracts meet these requirements.

A review of representative SQC literature revealed the following objectives: [Ref. 31]

a) It indicates the presence of assignable causes of variation;
b) It indicates the specific sources of these causes;
c) It is as simple as possible;
d) It leads to remote chances of searching for assignable causes of variation when these are not present;
e) It lowers costs, reducing labor and materials waste;
f) It improves quality, making such improvements uniformly throughout the entire production or service process;
g) It sets and adjusts tolerances and specification based on acquired production experience; and
h) It improves employee morale and the tenor of customer-vendor relationships.

Incorporation of SQC techniques in CA service contract administration may initially appear confusing. Proper training which presents it in a clear, concise manner should preclude this apprehension and lead to acceptance of SQC techniques by both government and contractor quality assurance personnel. Other possible objections are that SQC

techniques may not be appropriate for certain business or product lines, and managers may mistakenly belive that their services would always be performed in an excellent fashion, exclusive of the use of SQC methodology.

Such objections might be minimized if the advantages of SQC are presented. It reduces scrap and rework, increases quality awareness in all employees, and enhances productivity. This leads to increased quantities of improved products and services. Inspection becomes more scientific and reliable so that prediction of impending trouble can occur. Inspection costs are reduced, while authentic and accurate records of quality can be created.

C. LEGALITY OF STATISTICAL QUALITY ASSURANCE IN GOVERNMENT PROCUREMENT

1. Introduction

A primary goal of government procurement is to obtain timely and acceptable delivery of specified services. Contractors are alerted to this goal when the government includes mandatory clauses which state its rights in conducting quality assurance. A typical clause from Standard Form 23-A (Construction Contracts) is as follows: [Ref. 36]

> All work (which includes but is not restricted to materials, workmanship, and manufacture and fabrication of components) shall be subject to inspection and test by the government at all reasonable times and all places prior to acceptance. Any such inspection and test is for the sole benefit of the Government and shall not relieve the contractor of the responsibility of providing quality control measures to assure that the work strictly complies with the contract requirements. No inspection or test by the government shall be construed as constituting or implying compliance.

Additionally, other special inspection clauses may amplify unique quality requirements of a contract.

The government can exercise great latitude in its inspection of a contractor's performance, conducting it in a reasonable manner but increasing its intensity if significant defects in performance are detected. Unspecified means of testing are allowable as long as these are reasonable in conducting surveillance. Methods that increase contractual performance should not be utilized; concurrently, government surveillance should not interfere with contractor performance. Inspection by means of sampling procedures has been upheld in several cases presented to the Armed Services Board of Contract Appeals (ASBCA). [Ref. 36]

In any inspection system, the government must avoid the risk of effecting constructive changes to the contract by unreasonably elevating its own surveillance requirements or quality control requirements for the contractor.

2. Sampling Techniques Substantiated by Boards of Contract Appeals

SQC techniques have been sustained by the federal courts and by federal agency Boards of Contracts Appeals. In Vi-Mil Inc., ASBCA 16820, 75-2 BCA, para. 11435, MIL-STD-105D was utilized to properly estimate quantities of defective coats that occurred in several production lots. Government inspectors properly organized random samples to ascertain contractor performance and were correct in concluding that sample results were representative of entire production lots.

In Goldring Packing Company, ASBCA 7736, 1962 BCA, para. 3392, a government decision to terminate for default on the basis of sampling results was sustained by the Board. An inspector checked 11 meat loins out 114 total loins and found defects in each sample.

The government's choice of acceptable defect levels was sustained in Precision Products, ASBCA 14284, 70-2 BCA, para. 8447 in regards to sampling inspection. It was made clear that such choices must be based on reasonable government requirements; if defects are critical in nature, it is allowable to state that no defects or defective performance will be permitted.

With no method of inspection specified in the contract, the government proceeded to use sampling techniques in assessing product characteristics in Frank and Warren, ASBCA 10259, 65-2 BCA, para. 5102. The Board found that sample sizes utilized were sufficient to allow a termination for default.

In Associate Aircraft Tool and Manufacturing Inc., ASBCA 7255, 1963 BCA, the Board stated that:

> where the government purports to reject an entire lot of items on the basis of an inspection less than the full quantity delivered (the inspection sampling), the inspection sample must either be representative of the entire lot, or in accordance with a sampling and control plan agreed to in the contract.

The board also emphasized that inspectors properly designate the manner of forming inspection lots, the determination of sample sizes, and the manner in which contractors present lots for inspection.

Sampling procedures for inspection of manufactured products were included in contract provisions for Metal Tech Inc., ASBCA 14828, 72-2, para. 9545. The Board sustained the manner in which delivered items were rejected and sustained the government's termination of the contract, citing the Frank and Warren decision which stated that the government is not obligated to inspect each defect in all delivered supplies when forming a basis for lot rejection.

In a final case, American Quality Assurance Engineering, ASBCA No. 11417, 11466, 11544, and 11747, 68-1 BCA, para. 6986, the government used a liquidated damages clause which stated:

> The government will inspect approximately 10 percent of the tasks performed daily by the contractor. Of these an acceptable quality level of a daily average of not more than eighteen tasks has been established. If for any calendar month the contractor exceeds this average he shall pay to the government as liquidated damages for excess administrative costs the sum of $250.00. The daily average of unsatisfactory performed tasks is obtained by dividing the total of unsatisfactorily performed tasks for the month by the number of working days for the month.

In this case, government payment withholdings were in dispute. The government based these on judgmental samplings (not random). Some withholdings were sustained while others were denied by the Board. Deductions from total monthly invoices based on defect percentages observed in the sample were found to be correct. The Board disagreed with enlarging observed percentages to 100 percent of the projected deficiencies, and applying these to the entire month's performance; it believed that this enlargement was conjectural and lacked sufficient accuracy. Utilization of Mil Std 105D sampling techniques might have injected sufficient accuracy into the surveillance process, leaving no room for doubts about the propriety of deductions.

3. GAO Substantiation of Statistical Quality Assurance Techniques

A recent General Accounting Office (GAO) ruling substantiates government inspection by statistical sampling methods. In Environmental Aseptic Services Administration and Larson Building Care, B-207771 of 28 February 1983, GAO evaluated protests against Air Force implementation of extrapolated deductions using MIL-STD-105D. An issue of

dispute was the definition of work items, as each one might consist of several subsidiary tasks. For example, cleaning of rooms could involve sweeping floors, emptying trash cans, dusting blinds, and several other tasks. Because of the deduction provisions of an Air Force CA contract solicitation, the protestors claimed that one defective subsidiary task could lead to rejection of the entire room just as if all subsidiary tasks were judged to be unsatisfactory.

The GAO agreed, finding that the government requirements were not fair or reasonable and could be viewed as a penalty system. GAO recommended that the Air Force distinguish between vital and non-vital tasks, establishing reasonable deduction rates for both. This has resulted in more detailed breakouts of work requirements for certain Air Force CA contract solicitations.

The GAO emphasized that enclosing the quality assurance provisions in solicitations was clearly for the benefit of the government and not potential offerors. These can not be disputed, nor can failure by the government to adhere to them form a basis for protest.

4. Summary

The preceding discussion points out a sample of legal cases in which government use of statistical quality assurance techniques were disputed. These were found to be valid and applicable to government procurement. These techniques must be reasonable and not increase stated standards of performance. Use of SQC techniques are the prerogative of the government and not the contractor. Rejections or deductions based on sampling must be representative of the lots of work or service being performed.

SQC techniques have a legal basis when applied to CA service contracting. Ensuing discussion will examine various statistical methods which are being used or are being studied for their possible application.

D. AIR FORCE CA CONTRACTING UNDER AFR 400-28 AND MIL-STD-105D

1. Introduction

The Air Force first issued policy requiring the concurrent design of performance-oriented statements of work and matching quality assurance plans for CA service contracts in Air Force Regulation AFR 400-28. Subsequently, standardized statements of work and quality assurance plans which could be tailored to local command needs were developed and distributed. AFR 400-28 required the use of random sampling procedures based on MIL-STD-105D, along with other inspection methods. Other executive agencies followed the Air Force lead. The Office of Federal Procurement Policy issued OFPP Pamphlet No. 4, which embodies the procedures stated in AFR 400-28. The Naval Facilities Engineering Command issued its own maintenance manual, MO-327, which calls for performance-oriented statements of work but does not implement the use of MIL-STD-105D. NAVFAC is exploring the use of another statistical method, confidence level estimation, which is examined later in this study.

2. Military Standard 105D Concepts and Issues

Before examining specific Air Force SQC policy, it is necessary to elaborate on the basic statistical concepts and issues of MIL-STD-105D. These are based on acceptance sampling and are described in simple terms by A. J. Duncan, a noted SQC author: [Ref. 32]

> A company receives a shipment of goods. It samples the shipment and either accepts it as conforming to standards or rejects it. If the company rejects the lot as being below standard, it may be returned to the supplier or it may be kept, depending on how badly the goods are needed or what arrangements have been made with the supplier. Possibly there will be a price concession on rejected lots. It is to be emphasized that the purpose of acceptance sampling is to determine a course of action, not to estimate lot quality. Acceptance sampling

> specifies a procedure that, if applied to a series of lots, will give a specified risk of accepting lots of given quality.
>
> In other words, acceptance sampling yields quality assurance. It is also emphasized that acceptance sampling is not an attempt to 'control' quality. The latter is the purpose of control charts; these guide the engineer in modifying procedures so as to turn out better products.

Under acceptance sampling, the attributes of a product are judged. Attributes are that property of a unit that classify it as bad or good. Quality characteristics of a unit are either within specified limits, or are not conforming. [Ref. 11] Submission of good quality services results in high rates of acceptance, while products of poor quality incur a high rate of rejection.

For CA contracts, single sampling plans for fractions defective are used most frequently. These define a sample size that is to be taken and a number of defective units which can not be exceeded in order to prevent lot rejection. [Ref. 32] As an example, a sampling plan may call for a sample of 100 CA service work items to be taken from a monthly lot of performance. Two or less defectives result in lot acceptance, while three or more lead to lot rejection. Such stated constraints lead to the construction of an operating characteristic curve, which illustrates how the probability of acceptance of a lot varies with the quality of the material offered for inspection. At low rates of discovered defects, the probability of lot acceptance will be high. At high rates of discovered defects, the probability of lot acceptance will be low. Operating characteristic curve profiles can be adjusted by varying lot and sample sizes or by varying the acceptable defect rates (acceptable quality level, AQL) as shown in Appendix C. Such operating characteristic curves illustrate the protection offered to both contractors and government customers. Application of Military Standard 105D requires the following sequence of planning activities.

3. Planning Activity Sequence for MIL-STD-105D

a. Lot Sizes for MIL-STD-105D QA Plans

In using random sampling procedures and MIL-STD-105D guidelines, the size of work item lots must first be determined. Lots could be the total number of rooms in a building that are cleaned, the number of vehicles that undergo preventitive maintenance or the number of refuse containers that are serviced on a monthly basis. Lots can be accumulated on other than a monthly basis, but should be repetitive or continuous in nature. All lot items should be homogenous, or have the same characteristics.

b. Sample Size Determinations

When a lot size is known, tables in MIL-STD-105D are consulted to determine an appropriate sample size in judging the characteristics of the lot. For one lot size, there are three different sample sizes corresponding to three levels of inspection intensity. Level I is utilized when smaller, or reduced, sample sizes are sufficient; less discrimination is necessary.

Level II is the normal level of inspection intensity. Sample sizes derived from Level II tables are used most frequently for CA contracts.

Level III's larger inspection samples are used when more discrimination of product quality is necessary, resulting in tightened inspection. These are used when there are major observed declines in product quality.

c. Determination of Acceptable Quality Levels

The next activity in the sequence of designing a quality assurance plan is the determination of an Acceptable Quality Level (AQL). This variable is described in MIL-STD-105D as follows: [Ref. 35]

> The AQL is the maximum percent defective (or the maximum number of defects per hundred units) that, for the purpose of sampling inspection, can be considered satisfactory as a process average. When a consumer designates some specific value of AQL for a certain defect or group of defects, he indicates to the supplier that his (the customer's) acceptance sampling plan will accept the great majority of lots or batches that the supplier submits, provided the process average level of percent defective (or defects per hundred units) in these lots or batches is no greater than the designated value of AQL. Thus, the AQL is a designated value of percent defective (or defects per hundred units) that the customer indicates will be accepted most of the time by the acceptance sampling procedure to be used. The sampling plans provided herein are so arranged that the probability of acceptance at the AQL value depends upon the sample size, being generally higher for large samples than for small ones for a given AQL. The AQL alone does not describe the protection for individual lots or batches but more directly relates to what might be expected from a series of lots or batches, provided the steps indicated in this publication are taken. It is necessary to refer to the operating characteristic curve of the plan to determine what protection the consumer will have.
>
> The designation of an AQL shall not imply that the supplier has the right to knowingly supply any defective unit of product.
>
> The AQL to be used will be designated in the contract or by the responsible authority.
>
> The values of AQL's given in these tables are known as preferred AQL's. If, for any product, an AQL be designated other than a preferred AQL, these tables are not applicable.

Duncan states the following in reference to the AQL: [Ref. 32]

> In applying the MIL-STD-105D it is expected that in a conference between a supplier and a military agency it will be made clear to the supplier what, for purposes of acceptance sampling, the agency considers to be acceptable quality levels for product characteristics.

With a specified AQL and inspection level intensity, the sample size can be determined by using tables given in MIL-STD-105D. These also allow a determination of accept and reject numbers from these tables. The accept number is an important threshold; as long as the number of defectives found in a sample are less than or equal to this

value, the lot is accepted. If the number of defectives are equal to or greater than the reject number, the lot is rejected.

d. Inspection Schedule Design Using Random Number Tables

The next step in the quality assurance plan design is the choice of items that will be included in a sample by using random number tables. The process begins by assigning each item of work in a certain functional category (such as service of housing area trash containers) its own unique inventory number.

A random number table is then consulted. Correspondence between work elements in the lot and digits listed in the table is established (a numbering system). A route through the table is selected and is followed by choosing numbers according to this pattern. A starting point is fixed, and the table is used until the required number of sample items is chosen.

In using random number tables, the selection of inspection sample items occurs such that each has an equal chance of being included in a sample. Detailed, explicit instructions on random number table usage are provided in AFR 400-28, OFPP No. 4, and NAVFAC MO-327. The quality assurance inspector lists each item on a schedule and conducts inspections at the appointed time. Results are documented in writing to aid in determining the acceptability or non-acceptability of contractor performance.

e. The Disposition of Inspection Results

After inspection findings are complete, alternative courses of action may be pursued by the activity contract inspection division. When AQL's are exceeded, payment deductions or lot rejections may be made. If two of

five consecutive lots are rejected (AQL's are exceeded), tightened inspection is instituted utilizing larger sample sizes. Rejected lots may be resubmitted after defects are corrected, but this is done only at the discretion of the government.

When ten consecutive lots subject to tightened inspection are rejected, performance is halted. It is conceivable that a termination could ensue on or before this point. There is a provision for exceptional contractor performance. When ten consecutive lots subject to normal inspection have been accepted, a switch to reduced inspection (smaller sample sizes) may be made.

f. Overview

If quality assurance plan designs based on the preceding sequence of activities are conducted properly, MIL-STD-105D will provide for effective and reliable surveillance of CA service contracts.

The concept of acceptable quality levels must be carefully understood. It is not an aspect of specifications or of performance. It is instead a notification to contractors that government surveillance plans will allow no amount of defects observed in the sample to be greater than the AQL specified by the government. [Ref. 32]

The most commonly used table in the standard is the single sampling plan (Table II-A). It is designed so that along diagonal path in the table, the product of the AQL and the sample size is nearly constant. This has resulted in a limited set of AQL's which may be utilized, as shown in Appendix B.

One criticism of MIL-STD-105D is that probabilities of acceptance increase as sample sizes increase for one given level of AQL. When the standard was being formulated, some industrial engineering experts pressed for constant

probabilities of acceptance for any given AQL. This notion was rejected since it was believed that substantially greater risks are posed to suppliers of large lots (and corresponding sample sizes) when these are submitted for inspection, than for suppliers of smaller lots and samples. Increased sample sizes actually protect both government and contractor interests as these allow more accurate assessments of sample and lot qualities. Therefore, increased probability rates of acceptance with increased lot and sample sizes is logical. [Ref. 32]

4. Air Force Implementation of MIL-STD-105D in CA Contracts

In addition to statistical sampling techniques, the Air Force employs other surveillance methods. One of these, a management information system, is utilized to properly ascertain the contractor's performance. Information supplied by this method may obviate the need to install random sampling inspection systems. Such systems may be reports supplied by contractors, or by government customers who receive CA contract services.

Surveillance checklists are another method of CA surveillance suggested in AFR 400-28. However, this systemis not recommended if a management informations system or a random sampling system can be installed, since checklists are a form of planned sampling and may be subjective.

Formal customer complaint systems provide supplementary information describing contractor performance. Customer complaints, under Air Force policy, are seldom used in rejecting services or making payment deductions. When random sampling systems are in effect, these cannot function as substitutes for random observations, but may be used as supplementary documentation. Guidelines given in AFR 400-28 enable an activity to properly set up a customer complaint system.

AQL's are standardized values which are jointly determined by the field activity or its systems command headquarters. As an example, McClelland Air Force Base divisions submit prospective CA solicitations with desired AQL's to Air Force Logistics Command (AFLC) headquarters in Dayton, Ohio. AFLC headquarters either approve the activity choices of AQL's, or recommend changes. AQL's given in MIL-STD-105D tables must be utilized. AFR 400-28 calls for AQL selections that are realistic in helping to secure a minimum quality of service, since no service is capable of being perfectly performed. These are then communicated to CA contract bidders in a form entitled the Performance Requirements Summary (PRS) as shown in Appendix C. It lists each element of required performance, the standard for its performance, the maximum allowable deviation from this requirement, and the method of surveillance that will adjudge performance quality. [Ref. 39]

The contractor determines the percentage of each individual category of work in relation to the total contract value, entering these on Performance Requirements Summary sheets and returning them with the bid submission package. Such percentages are later used in making deductions for unacceptable performance.

It should be noted that the use of MIL-STD-105D may allow observed defects rates greater than the specified AQL when the contractor reaches or exceeds the reject number. For example, a lot of 2000 items is checked with normal sampling intensity (Level II) and an AQL of 10 percent. A sample of 125 items is required; the lot is to be rejected if 22 defects are observed in the sample. If 22 defects are later discovered, the observed defect rate (17.6%) exceeds the AQL (10%) and rejection would occur. Even though any defects greater than 13 would cause the observed defect rate to exceed the AQL of 10%, this method allows up to 21 defects to be accepted.

The Air Force has adopted a policy of assisting contractors in developing their own quality control programs. Accordingly, activities who issue CA solicitations enclose a copy of the quality assurance plan. This enclosure is marked as follows: [Ref. 39]

> For Information Purposes Only. This Quality Assurance surveillance Plan is not part of the Request for Proposal or Invitation For Bids nor will it be made part of any resulting contract.

A Contract Administrator plan can also be enclosed with the solicitation, describing Contract Administrator duties in evaluating the performance of Quality Assurance Evaluators (who inspect the contractor). Contract Administrators may also make random inspections of contract performance.

Contractors are provided appropriate pages from MIL-STD-105D to assist them in establishing their own quality control systems. Instructions are provided which describe how extrapolated deductions will be made when specified AQL's are exceeded. The contractor is never given schedules of inspection which have been developed from the random number tables.

The Air Force approach appears to be one of reasonableness. Conversations with personnel at two Air Force bases revealed that performance rendered under CA contracts with statistical surveillance methods is very satisfactory. Most problems occur in the initial transition periods of contracts (the first one or two months of performance). AQL's for most contracts at both installations have rarely been exceeded. Government personnel seemed to be pleased with the results of random sampling inspection methods.

Some deviations from MIL-STD-105D are detected in AFR 400-28. No provision is made for tightened inspections, as single sampling tables in the regulation address only normal (Level II : average quality) and reduced (Level I : good quality) inspection.

Switching from normal to reduced inspection under AFR 400-28 is allowed when four consecutive lots have been accepted, and the number of defects is less than one half of the specified acceptance number for normal inspection. The division manager and contract administrator must also agree to the switch. MIL-STD-105D allows this only after ten consecutive lots have been accepted. A return to normal inspection will be implemented if the acceptance number for reduced inspection is exceeded. Under MIL-STD-105D, a switch to tightened inspection is necessary when two of five consecutive lots are rejected. A switch from tightened back to normal inspection is allowed when five consecutive lots are accepted. AFR 400-28 does not incorporate a similar provision.

It might be reasoned that these Air Force deviations are meant to offer positive motivation to contractors in performing satisfactorily. These modified procedures are being utilized at most Air Force activities undergoing A-76 CA contract evolutions.

E. NAVFAC USE OF CONFIDENCE LEVEL ESTIMATION METHODS

The Naval Facilities Engineering Command (NAVFAC) has been heavily involved in the management of a growing number of CA contracts for facility related services at Navy activities. It is one of the first systems commands under the Chief of Naval Material (CNM) to address diverse issues in CA conversions and begin the formulation of policy to deal with them.

NAVFAC published the MO-327 to offer guidance to Navy activities in preparing performance-oriented statements of work and quality assurance plans. This guidance is similar to that provided in Office of Federal Procurement Policy Pamphlet No. 4, and allows inspection methods other than random sampling. NAVFAC has issued 20 standardized statements of work with matching quality assurance plans which can be tailored by Navy activities to incorporate specific local requirements. Portions of MO-327 are illustrated in Appendix D.

NAVFAC has not adopted the use of MIL-STD-105D as the basis for its statistical sampling techniques, and does not yet allow Navy activities to make extrapolated deductions based on its usage. Sampling techniques may be used at those Navy activities which demonstrate the ability to establish sophisticated quality assurance programs. New PWC transportation CA solicitations being issued in this fiscal year will include modified sampling techniques and extrapolated deductions provisions based on their usage.

NAVFAC philosophy is that CA contract surveillance should be based on the statistical estimation of defective items in samples, rather than on the accept/reject hypothesis testing methodology of MIL-STD-105D. Estimation is intended to inject a higher level of precision (confidence) in the surveillance process than that offered by MIL-STD-105D.

This methodology requires a designation of desired confidence levels, a relative accuracy of estimation, population sizes, and a threshold of conformance (equivalent to the AQL concept). Combining these elements results in a determination of sample sizes and corresponding lower confidence limit rejection numbers. For example, a work function is performed 2000 times in a month. A confidence level of 95 percent is desired in estimating the number of population

defects, with a relative accuracy equal to 50 percent of the designated AQL of 10 percent. (Relative accuracy then equals 5 percent). A sample size of 93 items is required, and rejection of the month's performance can occur if more than 16 defective items are found. Sixteen observed defects will result in proper lot rejection since the estimated lower confidence limit percentage for nonconforming items is always greater than the specified AQL of 10 percent.

NAVFAC has worked with the Office of Naval Research (ONR) in developing a set of new confidence level estimation tables which can be used to design CA contract quality assurance systems. These tables will reflect three different levels of inspection intensity (corresponding to various confidence levels), known as tightened (99 percent confidence), normal (95 percent), and reduced (90 percent) sampling. It appears that these new tables are based on the hypergeometric statistical distribution.

This new methodology emanated since NAVFAC doubts that MIL-STD-105D suitably estimates fractions of nonconforming activities with reasonable accuracy. This was illustrated earlier when observed defect rates at the MIL-STD-105D reject number were compared to the AQL's. NAVFAC also desires flexibility in choosing AQL's other than those provided in the standard's tables.

A primary emphasis in confidence level estimation is to determine the actual occurrence of defects in the population based on sample observations whereas hypothesis testing by attributes only determines if populations are acceptable or unsatisfactory.

NAVFAC has other reservations concerning the use of MIL-STD-105D. It does not believe that full payments should be made when the observed defect rate exceeds the AQL percentage, even if the reject number has not been exceeded, and questions the use of the standard where lots may not be homogenous and be submitted in a continous manner.

Other differences in Air Force and NAVFAC contract policy were observed during the study. The Air Force encloses copies of quality assurance plans with CA contract solicitations; NAVFAC contracting activities have not done so. Air Force contractors are notified of desired AQL's and the type of inspection method used in verifying these. NAVFAC will provide this information to prospective bidders in its future CA solicitations. The Air Force administers a management control program in which cognizant Contract Administrators conduct random checks of both inspector and contractor performance. NAVFAC has considered such a program but has not formerly instituted one.

TABLE I

Samples Sizes For MIL-STD-105D and Confidence Intervals

Lot Size	Sample sizes	
	MIL-STD-105D	Confidence Intervals
50	8	37
100	20	58
500	50	108
1000	80	121
5000	125	135
10000	125	136

These samples sizes are for normal inspection at 95% confidence, at an AQL of 10%.

The most noticeable difference in inspection philosophies is visible if sample sizes of each are compared over increasing lot sizes, as shown in Table I. Sample sizes under MIL-STD-105D are less than those for confidence level estimation for smaller populations. Two inferences can be drawn from this fact. If cost savings are of paramount

importance in conducting CA contract surveillance, then MIL-STD-105D sampling tables should be utilized because smaller numbers of required inspections result in less costs to the activity. However, if precision in adjudging contract performance is essential, then sampling under confidence level estimation should be utilized. The larger sample size provides greater reliability in assessing the number of defects that might be submitted. If costs of inspection are not great, this method is preferable.

In one study at the Charleston Naval Shipyard, random sampling procedures were used successfully for daily, repetitive services. All inspection personnel found these to be superior to former heavy reliance on planned sampling methods. Additionally, use of such techniques resulted in significant lowering of observed defect rates in contractor performance.

The authors were told that an informal DOD working panel of Air Force, Navy, and OFPP personnel will begin an evaluation of different available statistical methods when the new ONR sampling tables are complete. Until then, the only official statistical method available for use is MIL-STD-105D.

F. USING STATISTICAL SAMPLING RESULTS FOR EXTRAPOLATED PAYMENT DEDUCTIONS

As well as promoting more optimum use of costly inspection resources, SQC techniques provide another important benefit. Their results can be utilized in extrapolating, or applying the percentage of defectives found in samples to the larger lot populations.

The Air Force first mandated this procedure in AFR 400-28. When sample errors occur at a rate which is greater than the desired AQL and its corresponding reject number, a percentage found unacceptable results. It is subtracted from

100 percent to determine the lot percentage acceptable for payment, which is applied to the entire lot. Deductions are not taken when errors in a sample are less than the reject number.

NAVFAC policy has not allowed extrapolated deductions since it has no official statistical method on which to base these deductions; however, progress in developing such methods has led NAVFAC to envision alternative applications of extrapolated deductions to be utilized when a uniform DOD statistical sampling policy is adopted. Appendix E illustrates various Air Force and NAVFAC methods of making payment deductions for nonconforming service. The NAVFAC methods have not yet been promulgated as new CA contract policy. It should be noted that NAVFAC will deduct for all items observed to be in nonconformance. When contractors satisfactorily reperform these within allowable time frames, however, credit will be given for reperformed items. Liquidated damages are assessed as a percentage of all nonconforming items of work.

Promulgation of a uniform DOD statistical sampling policy will play an important role in allowing the use of extrapolated deductions based upon this technique. If sampling procedures are perceived to be unreliable, litigation proceedings may eventually prohibit the use of this deduction methodology.

G. AN OVERVIEW OF SQC TECHNIQUES FOR A-76 CONTRACTS

It should be apparent that the use of random sampling procedures in the new A-76 Commercial Activities program for DOD and other federal agencies offers significant cost savings in contract administration. Inspection costs are reduced, and incorporation of SQC techniques may lower the costs that contractors incur in performing such services.

These techniques offer fairness and objectivity that often were not present under former planned sampling and customer complaint programs. If SQC techniques are administered properly, they will render a much more accurate presentation of true contractor performance than was possible under former inspection methods.

Such techniques will be invaluable if large, multifunction contracts at federal activities become a reality (such as the total base operating services contract at the Naval Submarine Base Bangor, Washington). These will optimize the use of minimal government contract administration resources.

V. PLANNING AND BUDGETING FOR CONTRACT INSPECTION ORGANIZATIONS

A. INTRODUCTION

With the implementation of OMB Circular A-76, DOD activities that study CA functions must prepare for the possibility of a contract award by identifying and planning for certain support requirements that would be necessitated. Such plans include a quantification of inspection resources so that the activity's budget can accurately reflect fund requirements for either the creation of a service contract organization or for the augmentation of an existing one.

The Commander, Naval Facilities Engineering Command (NAVFAC) and the Commander, Naval Supply Systems Command (NAVSUP) have traditionally held contract authority for construction and procurement of supplies. Both have delegated contract authority to regional procurement commands such as NAVFAC's Engineering Field Divisions (EFD's), NAVSUP's Navy Regional Contracting Centers (NRCC's), and Naval Supply Centers (NSC's). These commands have further delegated contract authority to field activities. Along with this authority , field commands have been assigned the responsibility for quality assurance and surveillance of construction and delivered supplies . In the Naval Facilities Engineering Command, these are known as Resident Officers In Charge of Construction (ROICC). These field activities have been staffed with necessary quality assurance and contract specialist personnel to administer construction and supply contracts. Additionally, the responsibility for the preparation of contract solicitation packages (for example, the design of construction projects)

has usually been assigned to the regional contracting office or to the requiring activity.

This pattern of contract authority and surveillance responsibility does not apply, however, for CA service contracts. Neither NAVFAC nor NAVSUP have been provided with sufficient staffing resources to provide on-site surveillance and administration of contracts resulting from A-76 cost studies, although both systems commands retain contract authority for CA contracts. Navy activities that receive services under these contracts prepare the statements of work, quality assurance plans, and provide an on-site surveillance organization to ensure proper contractor performance.

A Chief of Naval Operations message that was promulgated on 22 November 1982 delineated different roles for both contracting agent commands and customer activities in their implementation of the CA program. The following responsibilities are identified: [Ref. 37]

a) Contracting Office
    i) Processing of contract documents which requires exercise of contract authority,
    ii) Negotiation of all contract changes,
    iii) Direction of remedial contractor action,
    iv) The processing of contractor payment requests,
    v) Delegation of authority to the customer activity for any day-to-day surveillance of the contractor's work performance,
    vi) Maintenance of integrity throughout this process,
    vii) Provision of all technical advice, and
    viii) Provision of assistance in the development of training programs for all personnel involved in contract preparation and administration.

b) Customer Activity

- i) Provision of qualified personnel to inspect work delivered under the contract,
- ii) Preparation and implementation of quality assurance plans,
- iii) Submission of quality assurance summary reports to the contracting agent,
- iv) Evaluation of contractor requests for payment,
- v) Recommendation of payments or deductions to the contracting agent,
- vi) Submission of cost estimates to the contracting officer for proposed modifications,
- vii) Provision of assistance as required to the contracting agent during modification negotiations, and
- viii) Performance of other service contract support duties when these are delegated by the contracting office.

NAVFAC has alerted all Navy field activities and major claimants of this division in service contract responsibilities in both an instruction (NAVFACINST 4330.45) and a new maintenance manual (MO-327). The Air Force has adopted a similar approach which is specified in two separate Air Force Regulations (AFR 400-28 and AFR 70-9). They require that the functional divisions of each Air Force base prepare both the statement of work and corresponding quality assurance plan. The division must provide all necessary quality assurance personnel and, prior to the contract solicitation, certify in writing to the base Commanding Officer that these personnel have been designated, trained, and dedicated solely to perform surveillance functions. [Ref. 38]

At two Air Force installations visited during the research phase of this thesis, it was discovered that a consolidated steering committee is organized upon the formal

announcement of a CA cost study. It includes representatives from all departments that might be affected by the contracting out of a function and tailors standardized Air Force statements of work that have been prepared for each CA function, identifying and including all special local command requirements. The steering group also provides assistance in the development of the quality assurance plan.

B. THE ESTIMATION OF REQUIRED INSPECTION RESOURCES

At the outset of a cost study announcement, an activity must begin to define and plan its quality assurance requirements. [Ref. 39] The planning and budgeting responsibility for obtaining inspection resources belongs to the activity. Each Navy activity should immediately begin the planning for a contract administration staff, establish ongoing interface with the appropriate major claimant to document these requirements, estimate future budget amounts, and obtain ceiling points to facilitate the creation of this vital organization.

Various procedures have been used for determining the required quantity of service contract administration resources. In the supplement of the 1979 revision of A-76, it was stated that costs of administration resources were to be estimated to be four percent of the projected award cost of a service contract. This factor is useful only as an approximate estimate of inspection requirements. Actual inspection costs might range from ten percent for small service contracts to only two percent for large BOS contracts. Use of this simple estimating factor does not account for differing degrees of complexity among contracts; however, it may be satisfactory as an initial estimating tool. [Ref. 5]

Another simple estimating model for determining inspection requirements has been recommended by the the Southern Engineering Field Division (SOUTHDIV) of the Naval Facilities Engineering Command. It recommends that activities can plan to use 875 hours of inspection for every $300,000 dollars of refuse collection service contracts, while all other service contract types require at least 1,325 hours of inspection for every $300,000 of contract costs. This model, like the previous one, is primarily useful for making rudimentary projections of service contract inspection requirements.

TABLE II

New A-76 Contract Administration Factors

In-House Staff Positions Being Studied	Contract Administration Staff Requirements
Below 10	Use existing staff
10 - 20	1
21 - 42	2
43 - 65	3
66 - 91	4
92 - 119	5
120 - 150	6
151 - 184	7
185 - 222	8
223 - 265	9
266 - 312	10
313 - 367	11
368 - 429	12
430 - 500	13
501 - 583	14
584 - 682	15
683 - 800	16
Above 800	2% of In-House Staff Est.

The 1983 proposed revision of Circular A-76 provides guidance shown in Table II that relates the number of personnel required for contract administration to the number of personnel positions being studied for conversion. It

shows how to estimate the required contract office staffing. This particular methodology, as the two previous ones, may not account for differing complexities which exist in service contracts.

$$C = 69.74 + (0.183)(A) + (7.29)(B)$$

Where A = Total Service Contract Value ($,000)
and B = Total # of Service Contracts
QAE's required = C divided by 144

Figure 5.1 Inspector Hours Regression.

Another method for estimating the number of required inspectors is found in the Student Guide for Maintenance Service Contracts published by the Civil Engineer Corps Officers School. This mathematical method, depicted in Figure 5.1, is an estimating model that relates the number of required inspectors to the total monetary value and number of the activity's service contracts. [Ref. 40]

The Atlantic Engineering Field Division (LANTDIV) of the Naval Facilties Engineering Command has proposed an alternative which may be the most viable one recommended thus far and is provided as Appendix F. LANTDIV Instruction 11014.4D recommends the use of a standardized worksheet to accurately estimate required inspection resources. It requires the specific quantities of various work elements to be performed under the contract on a monthly basis, estimated number of inspection hours to observe these, and the total number of hours to inspect individual categories as well as the total contract performance for each month. This estimation will allow a determination of the required number of inspectors, based upon a total estimate of inspection manhours.

Utilization of this worksheet should result in more accurate calculations of inspection personnel resources that are required if a new contract is awarded. This approach may also lead to the creation of sufficient data that can be used in the development of engineered performance standards for inspection of commercial activities service contracts.

If any of the above estimating models prove to be unsatisfactory, then the safest means of estimating personnel requirements may be to predict that one new inspector will be necessary for each new function to be awarded. This may be especially true if the inspection forces are located under a functional department, as is often the case for Air Force service contracts.

Inaccurate estimates of required staffing may create serious problems for activities that continue to contract out under A-76 guidelines. Navy activities must carefully design all of their quality assurance plans and calculate the required number of inspectors and staff personnel to execute them. Although current policy dictates that definitized quality assurance plans and organized quality assurance staffs will be established before contract solicitations, research for this study indicated that formal quality assurance plan designs often lag contract award. Activities that were visited frequently used existing personnel to provide surveillance on the new CA contracts.

Action pursued in accordance with these considerations will be essential to safeguard the activity's interest in a growing trend of contracting out for the Navy's commercial services. If this evolution is not planned properly, ineffective or erratic government surveillance may result. Such a condition can be a significant factor in those contract litigations or disputes which arise when the propriety of government inspection is a major issue.

C. QUALITY ASSURANCE TRAINING

Up to this point, it has been emphasized that the determination and staffing of a sufficient number of contract inspection and administration personnel is vital to a successful implementation of A-76 objectives. An equally important consideration is appropriate training of those personnel who will be involved in contract surveillance. Even if no additional inspection personnel can be obtained through budgetary procedures, the activity will still be required to provide a cadre of inspectors from existing personnel assets who will need to be knowledgeable in surveillance techniques. [Ref. 41]

During this research, it was discovered that two Air Force activities designate and train Quality Assurance Evaluator (QAE) candidates during the statement of work preparation process in accordance with Air Force Regulation 70-9. Current Navy policy has left the choice of inspectors and training responsibility to the discretion of each activity's Commanding Officer. Navy guidance in this area (that of NAVFAC and NAVSUP) has been only advisory in nature. The only written mandatory requirements levied upon Navy activities is that they prepare and submit a quality assurance plan to contracting agents for approval prior to solicitation; they must also certify in writing that a quality assurance workforce will be established or augmented prior to the contract award. These requirements have been addressed in recent NAVFAC Engineering Field Division guidance that pertains to CA service contracting.

Newly designated Quality Assurance Evaluators cannot be expected to immediately and professionally execute their surveillance responsibilities until they have been qualified by means of a formal training process. This may require attendance at a special school designed to teach various CA

quality assurance responsibilities. It may also involve an ongoing, less formalized training process that is carried out by skilled quality assurance specialists who reside at or visit the activity.

Service contract training courses have been designed and are being taught to the growing number of federal personnel who perform surveillance functions. For the Air Force, training is conducted by a quality assurance program coordinator. The QA Program Coordinator serves in a general advisory capacity and monitors the performance of functional department QAE's after they complete initial training and begin performing surveillance duties. QAE candidates receive basic training in contract law and administration, quality assurance duties and responsibilities, and an overview of the quality assurance plan . The training responsibility for Quality Assurance Evaluators is placed at the activity level under Air Force procedures. Quality Assurance Evaluators are identified and trained before the contract solicitation process begins .

For the Navy, Quality Assurance Evaluator manning is handled by the activity and the training is carried out by the nearest Engineering Field Division. The Facilities Division (code 10) of each NAVFAC EFD provides this training to naval activities in its geographic area. Training of Navy QAE's is a contracting agent responsibility. EFD's also provide technical support to each activity during the statement of work and quality assurance development processes.

The Naval Facilities Engineering Command has developed its own training manual which describes the specific roles assigned to quality assurance evaluators. This manual is known as MC-326.2, "Quality Assurance Evaluators Training Manual" and is utilized by each Engineering Field Division in its quality assurance training presentations. Quality assurance evaluators perform the following duties which are listed in MO-326.2: [Ref. 42]

a) Review plans and service contract specifications before contract solicitation;
b) Assist in pre-award surveys;
c) Attend the pre-bid and post-award conferences;
d) Coordinate transfer of government furnished space, utilities, equipment and material to the contractor;
e) Prepare quality assurance plans;
f) Prepare surveillance schedules, perform surveillance, and submit reports of findings;
g) Review all contractor schedules and advise Service Contract Manager of acceptability;
h) Assist in the preparation, or directly prepare, government estimates for change orders;
i) Recommend deductions for unsatisfactory work to the Service Contract Manager;
j) Monitor the contractor's safety practices and report results;
k) Conduct labor standards interviews as necessary; and
l) Conduct surveillance on the contractor's accomplishment of required corrective changes.

It should be emphasized that this list is not exhaustive. In spite of an implicit policy that quality assurance evaluators should be dedicated solely to surveillance functions, they may work for functional managers and perform several other duties in addition to their surveillance responsibilities.

When considering QAE responsibilities, it is evident that a well organized training course addressing several elements of contract administration is essential. Additionally, the course must be presented in a clear and concise manner using terminology that is easily understandable by the layman. Training in basic contract law, administration principles, cost and price analysis, organization structure, and contract specifications should be

covered . An equally important topic which must be included in any quality assurance courses for service contracts is statistical quality assurance. As discussed earlier, the use of statistical sampling techniques has been advocated for the inspection of commercial activities service contracts. It offers significant advantages over the use of one hundred percent inspection and reliance upon customer complaints.

Specific training in the use of Military Standard 105D and random number tables is required. Inspectors should know how to form homogenous lot and sample sizes, establish realistic acceptable quality levels (AQL's), create monthly random sampling schedules, and conduct inspections. Finally, inspectors will require instruction in properly disposing of unacceptable variances from required performance. Statistical quality assurance may initially appear confusing, but a well designed training program will reveal it to be a much simplified and useful approach. Random sampling will be more effective than 100 percent inspection or planned sampling techniques and requires fewer inspectors. A key requirement for effective service contract courses is the presentation of random sampling inspection in a simplified and understandable manner. Different DOD training courses have been designed with all of these requirements in mind; the implementation of a uniform DOD correspondence course could further facilitate successful QAE training.

One essential requirement for an adequate training program is sufficient funding to cover costs of providing necessary training to new quality assurance evaluators at field activities. Effective quality assurance programs to administer CA service contracts will be created and sustained only when activities and claimants identify, plan and budget for comprehensive training programs.

Study observations revealed that several Navy activities have attempted to send Quality Assurance Evaluators to appropriate training courses but insufficient funds have prevented attainment of this goal. It was observed that on-site training programs were generally non-existent, and should be initiated to enhance the skills and capabilities of Navy Quality Assurance Evaluators.

D. INTEGRATING RESOURCES TO BUILD A QA PROGRAM

Thus far, three basic building blocks for an effective quality assurance organization have been discussed. These are the obtaining of sufficient personnel, training of QAE's, and funding of inspection resources. If any of these elements are inadequate, the quality assurance program to support A-76 contract conversions will be jeopardized. Perhaps the underlying intangible element that ties all of these together is commitment. The activity Commanding Officer, the base personnel, the major claimants, and the various contracting agencies will need to form a coalition to accurately plan and provide for the proper integration of these building blocks. In the case of the Navy, cooperative attempts are being pursued to bring about successful contracting out .

The authors found wide variations in these efforts. Formal design and implementation of quality assurance plans has lagged the awards of many CA contracts and many contract inspection systems at Navy activities are not yet formalized. Random sampling inspection is used at very few Navy activities that administer service contracts. Some reasons for its infrequent usage are that it seems to be too complicated and that extrapolated deductions are not yet allowed for Navy contracts utilizing random sampling. Those Navy activities visited believed that the formation of a field

contracting system for service contracts that approximates the organization for construction contracts will make the administration of such contracts more viable and effective.

The size of the inspection organization and the sophistication of the predesigned quality assurance plan determine the adequacy of the overall contract administration system for CA contracts. Adequate staffing and a sound inspection plan will lead to successful surveillance, winning the cooperation and support of both the contractor and the base communities that receive services. This plan will optimize the use of inspection resources. Effective scheduling of inspectors and audits of contract administration can be achieved. An alternative, less optimal approach is to allow quality assurance planning to be limited by inspection resources that are available to the activity. It is likely that this option will be the one most often chosen if activities do not perform the necessary pre-contract planning and budgeting for the formulation of CA contract organizations.

VI. ORGANIZATIONS FOR A-76 SERVICE CONTRACT MANAGEMENT

A. MANAGEMENT OF SERVICE CONTRACTS AT NAVFAC HEADQUARTERS

Preceding discussions have set the tone for the predominant issue of this chapter, the makeup and location of service contract inspection and administration organizations. It is first appropriate to examine the organizational structure for management of service contracts at NAVFAC headquarters.

NAVFAC has located management of service contract policy for facility support contracts with the Assistant Commander for Maintenance and Transportation (code 10). This is also true for the management of service contracts at the Engineering Field Division level, where a similar Maintenance Division (code 10) oversees the evolution of Navy CA service contracting. Authority for all contracts (Commercial Activities or construction) is vested in the Acquisition Department (code 09A) at both headquarters and EFD levels. A typical Engineering Field Division performs the following management and contract duties for A-76 procurement: [Ref. 43]

a) Distributes contracting directives and provides guidance to field contract offices;
b) assists activity contract offices during contract disputes;
c) oversees the operation of activity contract offices to ensure the integrity of CA service contract processes;
d) reviews activity requests for sole source procurements and refers these to NAVFAC when appropriate;

e) acts as the central point of contact in the region for all CA service contract matters;

f) maintains a technical library to support compliance with the A-76 program, and provides technical information to customer activities;

g) assists activities in statement of work and quality assurance plan development;

h) conducts QAE training programs; and

i) reviews each activity's statements of work and corresponding quality assurance plans before contract solicitation.

By comparison, overall management of the Air Force CA service contract program is conducted at the headquarters level by the Air Force Service Contract Advisory Group (AFSCAG). Intermediate systems commands such as the Military Airlift Command (MAC) or Air Force Logistics Command (AFLC) may publish amplifying guidance to supplement two primary Air Force regulatory policies for service contracts, AFR 400-28 and AFR 70-9, as shown in Appendix H. [Ref. 44]. This comprehensive management is also visible at the activity level when functional divisions develop statements of work suitable for the activity's requirements. Intermediate systems commands grant final approval to activity statements of work before issuance of contract solicitations.

In late 1982, a few of NAVFAC's Engineering Field Divisions began to consider the consolidation of all contractual, planning, training and technical support for CA service contracts in one Facility Support Contract Branch. This head of this branch may be delegated contractual authority that is separate and distinct from that authority held by the department head for facilities construction and may be able to further delegate CA contract authority to responsible cognizant individuals at the field level (such

as the field activity's Public Works Officer). This concept is still under study, offering striking possibilities for the future administration of NAVFAC's service contracts. Perhaps NAVFAC will consider the creation of a separate service contract organization that is an exact likeness of the one for construction since the staff and expertise to manage such a program is largely in existence at NAVFAC headquarters, Engineering Field Divisions, and the large Public Works Centers. Such a new organization would require the establishment of field activity service contract offices to promote uniformity in administration of A-76 contracts and establish management control of the service contract process, and in turn promote NAVFAC's credibility as a service contract management agent.

B. THE ACTIVITY ORGANIZATION STRUCTURE

1. Introduction

In the current A-76 setting, most commercial functions are related to facilities or supply management. Accordingly, the officials who are responsible for these areas at most naval activities are either the Public Works Officer or the Supply Officer. Such functions are vital to successful accomplishment of the activity mission, and failure to provide them in a timely, cost effective manner could seriously jeopardize the operating posture of the activity. Most functions are currently performed by federal civilians or military personnel, but growing trends in contracting out under the A-76 policy signal a change.

2. Typical Public Works Department Functions

A sample of the different roles performed at a typical Navy Public Works Department is as follows:

a) Engineering Division
   - i) Prepares and reviews data for military construction and special projects programs;
   - ii) Provides design services and prepares plans and specifications;
   - iii) Interfaces with architect-engineer contractors; and
   - iv) Provides general technical assistance to other command organizations.

b) Maintenance Control Division
   - i) Receives and maintains control of work requests, facility inspection requests, and job orders;
   - ii) Manages a continuous inspection program for all command facilities;
   - iii) Prepares work plans; estimates manpower and materials requirements for job orders; and
   - iv) Manages the administration of maintenance service contracts.

c) Housing Division
   - i) Manages family housing operations;
   - ii) Arranges inspections and maintenance of family housing; and
   - iii) Assists in budget preparations.

d) Maintenance Division
   - i) Maintains all facilities; and
   - ii) Accomplishes maintenance under emergency service requests or specific job orders.

e) Utilities Division
   - i) Operates and maintains all command utilities equipment and structures.

f) Transportation Division
   - i) Operates and maintains a motor pool;
   - ii) Examines and licenses all government equipment operators; and

iii) Identifies and determines transportation equipment requirements.

This breakout of Public Works Department tasks identifies areas subject to CA cost studies: maintenance, utilities, and transportation operations. At many Navy activities, such cost studies are in progress.

3. Previous NAVFAC CA Service Contract Administration

An important step in the A-76 service contract process is the choice of a suitable organizational structure to manage the activity's contract administration responsibilities. NAVFAC has left the choice of the size, location, and professional skill capabilities for this new organization to the discretion of the activity Commanding Officer. He is tasked to provide surveillance since contracting agents have not been given sufficient funds or personnel resources to manage CA contracts. Before the Commanding Officer builds such an organization, he should be informed of those factors which should influence its design.

Traditional work planning, control and post performance inspection of Public Works maintenance and service operations have been performed by the Maintenance Control Division (MCD) of the Public Works Department (possibly excluding utilities and transportation operations). MCD inspectors prepare job orders for shops personnel and estimate time and material requirements based upon engineered performance standards. Inspectors periodically visit job sites to verify proper performance of repairs and maintenance. They also compare actual job expenditures with original estimates. As CA service contracting became part of Navy facilities management, inspection responsibilities have been assigned to Maintenance Control Division personnel. Initial types of contracts inspected include custodial services, grounds maintenance, refuse collection, and

housing facilities maintenance. Sometimes this responsibility is shared between MCD inspectors and base tenants when the volume of contracted services increases significantly. This shared responsibility has resulted in somewhat tenous CA contract administration.

Reliance upon base customers to provide required surveillance is not always a suitable practice. There is always a danger that customers acting in a contract inspector's role will exercise implied or apparent authority in dealing with the contractor. Constructive changes or unauthorized changes in scope can lead to counterproductive disputes and litigation; these do not serve the best interests of either the government or the contractor. Where customer surveillance methods are used in a way that contract performance standards are ultimately raised, then relief will generally be provided to the contractor under a changes or disputes process. A surveillance system which depends heavily upon customer observation of a contractor is not desirable for use in the CA service contract quality assurance process. [Ref. 42]

Increasing work volumes attributable to service contract conversions make establishment of centralized service contract management organizations advantageous to successful CA contracting. Such organizations are separate, distinct station divisions, act as key monitors of service contractor activity, and will probably be located within Public Works or Supply Departments. The CA contract inspectors in such divisions possess a wide range of technical skills so that full contract surveillance can be provided. This arrangement enhances management control and maintains integrity in the contract process.

If a centralized organization (with all QAE's working under one quality assurance manager) is not attainable, then other less optimal organization arrangements

exist. These are illustrated and explained in Figures G.1 through G.4 in Appendix G. These figures show that a Facility Support Contract Office can administer CA service contracts of a facilities nature, being located as a separate division of the Public Works Department (PWD) or as a subdivision of the PWD Maintenance Control Division. QAE's may work in the proposed central organization, or may work for functional division managers. [Ref. 45]

4. The Navy Service Contract Manager

A key player in NAVFAC's service contract process is the Service Contract Manager (SCM), the head representative of the activity's quality assurance team. His role is described as follows: [Ref. 28]

> The Service Contract Manager is that person with direct responsibility for day-to-day managemement of the service contract. Prior to award he is responsible for assisting in the preparation of the statement of work, the government estimate, and the surveillance plan. Post award responsibilities are to ensure that the contract runs smoothly and is properly managed, that surveillance is conducted, and documented, that contract working files are maintained, and that work orders are properly coordinated with the Officer-in-Charge. If change orders are required, the SCM must process them and make a recommendation to the Resident-Officer-in-Charge to issue a change; if the contractor is having problems, the SCM must recommend required action to the Resident-Officer-in-Charge in matters involving quality, time, money, or safety, and must coordinate these matters with the contractor, the contract specialist, and the Resident-Officer-in-Charge.
>
> The quality assurance program provides the Service Contract Manager with information on the contractor's performance. The SCM has technical and supervisory responsibility for this program.

This individual may be either an Engineering Field Division asset or may be on the field activity's rolls, and possesses an appropriate level of contract authority. The SCM is skilled in the use of statistical quality assurance and is able to plan and manage random sampling surveillance. He probably has a public relations role. Navy SCM's may be

either military officers or civilians. For the Air Force, this player is known as the Quality Assurance Evaluator Program Coordinator; the major difference between Air Force and Navy roles is that the SCM has supervisory responsibility over QAE's, while the QAE Program Coordinator possesses advisory responsibility only.

5. A Choice Of Centralized or Decentralized Organizations

In creating the CA service contract management organization, several alternatives may be considered, ranging from decentralized to centralized formats. The centralized organization has already been discussed; the Service Contract Manager is completely in charge of this type of structure. Contract specialists and quality assurance personnel report to the SCM who usually is a division head reporting to the activity Public Works Officer or Supply Officer.

At the other extreme, the SCM is a staff advisor with partial supervisory responsibility over inspectors, with all quality assurance personnel being assigned to functional department managers. The SCM may find it difficult to mandate specific detailed procedures to be followed in executing the surveillance program, with the possible loss of management control being most pronounced under this scheme.

Other variations might locate the contract manager within other divisions. For example, he may report to the activity's Maintenance Control Director. There may also be more than one SCM manager for an activity. Finally, all functional division heads, given the proper amount and level of training, could conceivably become Service Contract Managers .

The Air Force utilizes the following CA contract management structure. All Quality Assurance Evaluators are assigned to functional managers and are assisted in their duties by the QAE Program Coordinator, an expert in the field of service contract surveillance. QAE's are always designated in writing, and a candidate's final approval is decided by the installation commander. Training and surveillance of QAE activities is handled by the QA program coordinator. Location of the quality assurance organization is decentralized pursuant to policy stated in AFR 70-9. Some Air Force activities formerly utilized centralized QAE organizations; the authors' conversation with Air Force sources revealed that such organizations no longer exist.

No Navy policy exists that mandates either decentralized or centralized organizations. At larger Public Works Centers, trends seem to indicate that centralized types of organizations manage the administration of service contracts. Within Public Works Departments, either type of organization may be found. Based on the small sampling taken, larger Public Works Departments probably locate all QAE assets and the Service Contract Manager within the Maintenance Control Division.

Centralization of QAE assets is desirable for several reasons. One is that effective contract management control must be established. Inspectors placed under functional managers may have little or no allegiance to maintaining the integrity of the service contract process and may not be able to conform with standards set by the SCM. There are no guarantees that Quality Assurance Evaluators will be dedicated strictly to performance of inspection. Thus, overall integrity of the service contract process may be sacrificed where the surveillance responsibility accrues to a functional division head. Work ordering inputs may not be kept distinct from work output verification processes for the contract, leading to possible conflicts of interest.

Special qualities of the Service Contract Manager were described earlier. His responsibility for growing numbers of A-76 service contracts makes it necessary to appoint him as a division head.

The most important reason not to locate QAE personnel under functional management is to preclude the inadvertant communication of invalid implied contractual authority to the service contractor. Air Force limitations on QAE roles are spelled out as follows: [Ref. 38]

a) QAE's will not clarify, interpret or infer legal interpretations of contract scope or intent;
b) QAE's will not give direction to contractor employees;
c) QAE's will not enter into unauthorized contract agreements (including modifications);
d) QAE's will not require work to be done that is not specifically called for in the contract; and
e) QAE's will not authorize expenditures of funds.

These actions are the responsibility of the cognizant contracting agent. In a centralized staffing arrangement, the SCM can readily identify and ascertain the actions of the Quality Assurance Evaluators via daily inspection reports. The SCM will be more successful in providing training for QAE's and assisting in their professional self development. The Quality Assurance Evaluators can more readily avail themselves of contract administration assistance and cooperate to establish integrity in the CA contract process.

Functional managers may oppose this centralized inspection organization concept on the grounds that they will lose direct control of their operations. They may strongly believe that the quality assurance function is an inherent responsibility of their organization, and that no outside centralized department should interfere with their assigned missions.

One distinct benefit resulting from a centralized arrangement is easier tracking and budgeting for the full costs of service contract administration. Such costs may be more difficult to identify for decentralized organizations.

An area of uncertainty in the use of a centralized organization involves job qualifications for QAE's who inspect unique technical CA functions. In the Public Works environment, this issue might pertain to inspection of utilities and transportation equipment service contracts. The activity must balance its choice between requirements for specialized inspection skills and general knowledge of the technical area.

6. GAO Examines DOD Management Control of Service Contracts

Two recent General Accounting Office reports which examined and criticized existing federal agency administration of facility service contracts lend credence to the establishment of centralized inspection organizations.

A report entitled "Better Management Needed in DOD to Prevent Fraudulent and Erroneous Contract Payments to Reduce Real Property Maintenance Costs" of 9 January 1980 uncovered several instances of overpayments to contractors where work was either not performed or found to be unsatisfactory. GAO pointed out a lack of effective inspection procedures and internal management controls. Inspector reports were often erroneous and unreliable. GAO called for independent audits of each inspector's performance. Specific GAO criticisms were: [Ref. 46]

a) work performed was not billed in accordance with contract provisions;

b) inferior work was accepted;

c) less expensive materials were substituted for those specified in the contract; and
d) some work was paid for more than once.

Some GAO recommendations for improvements were as follows: [Ref. 46]

a) ensure that activities provide sufficient numbers of adequately trained contract inspectors;
b) require that routine independent tests of each inspector's work be made;
c) ensure that the proposed work is adequately planned before contract award and that contract specifications are clear and appropriate;
d) continue to devote a portion of internal audit effort to local procurement activities; and
e) require that detailed inspection records, including measurements and calculations, be maintained in support of contract payments.

These recommendations might be better attained with a centralized CA contract managmenent organization. The National Aeronautics and Space Administration was criticized by GAO for certain inadequacies in its contract management procedures in a 21 October 1980 report. Specific findings included: [Ref. 47]

a) a contractor was working without approved work orders;
b) questionable reimbursements occurred for the contractor's work;
c) contract funds were increased before the need was justified; and
d) some contracting officers had a general attitude that small dollar value contracts were not worthy of adequate attention.

Again, such problems might be mitigated under a centralized mode of contract surveillance and administration. Both reports emphasize the importance of properly organizing and locating a CA service contract administration organization. The activity may obtain the right number of inspectors, properly train them, and then gain nothing if it does not join these professionals as a unified team to handle newly acquired surveillance responsibilities. The Northern Division of the Naval Facilities Engineering Command (NORTHDIV) is investigating alternative structural arrangements (depicted in Appendix G) and has asked customer activities to provide opinions pertinent to this organizational issue. [Ref. 45] As stated earlier, no mandatory NAVFAC policy has been established. A wide divergence in attitudes and motivations at various Navy activities may be reason to refrain from mandating a specific policy. Immediate dialogue on the issue at DOD policy-making levels may help to establish standardized CA inspection organization guidelines.

Other advantages of centralized inspection are more careful assessments of proposed changes to current workload and increased flexibility to adapt to these. More effective inspector autonomy will allow the QAE to set schedule priorities and choose appropriate surveillance methods.

In decentralized organizations, inspectors may be constricted in exercising such flexibility and their schedules may be based on the personal whims of the functional manager. One primary objective in creating an organizational format is to grant the inspectors proper responsibility and control.

7. A Summaray of Advantages and Disadvantages of Centralization

Based on the preceding discussion. the comparative advantages and disadvantages of a centralized organization are presented:

a) Advantages:

i) More effective and reliable management control mechanisms can be instituted by the Service Contract Manager to establish contract integrity.

ii) Allegiance of Quality Assurance Evaluators is obtained in ensuring that services are delivered as required by the contract. No dilution of inspector motivation results by placing the inspector under functional area managers who may not appreciate the nuances of contract surveillance.

iii) Ultimate inspection costs may be less with centralized organizations.

iv) Centralized divisions may promote a greater sense of professionalism among Quality Assurance Evaluators. Statistical quality assurance techniques and contract administration procedures are mastered by each inspector through constant cooperation and interface with the SCM.

v) The contractor's interests are better served by a centralized organization; lines of authority are more visible and understandable.

vi) Opportunities for mismanagement and occurrance of fraud should be lessened.

vii) By creating a centralized organization, the activity more readily assigns a proper priority to management of CA contracts and gains a more

credible position when it requests additional funding or training support.

- viii) Better opportunities for employee self development exist. Training can be easily secured and managed. The SCM will be able to better assess the necessary requirements for each inspector's self development.

b) Disadvantages

- i) Certain CA functions may require technical expertise that is not available in the existing QAE resources. By not placing the surveillance for these under functional manager control, work performance may be jeopardized.
- ii) Functional manager objections must be dealt with. These might be a perceived lack of control that result from the inability to deal with contractors in a face-to-face relationship. They could also feel that centralized inspector organizations will be largely insensitive to special concerns. The end result of such apprehension may be refusal to cooperate with the inspection organization and the contractor.
- iii) At small naval activities, the cost of a centralized division may exceed the cost of placing each inspector under functional division heads.

Earlier study discussion examined the feasibility of a new contract agency organization structure for the CA service contracts that includes Navy intermediate and field commands. If these activities embrace the concept of centralized service contract divisions, the Navy will have moved one step closer to its creation.

Use of centralized organizations will be advantageous should an activity choose to use large Base Operating Support type contract solicitations. The activity may also desire to form quality assurance teams for specific contract types which exhibit a combination of both decentralized and centralized formats.

C. JOB SERIES DESCRIPTORS FOR SERVICE CONTRACT MANAGERS

This study has carefully described a process for building a successful contract quality assurance organization at the field level, emphasizing the formation of a separate division to manage the administration of a growing number of A-76 CA service contracts. This occurs after the activity defines, estimates, and budgets personnel requirements to carry out the performance of each contract's quality assurance plan. This process will be an ongoing one as increasing CA contracting occurs.

During this process, the activity needs to define and determine skill and knowledge requirements for that person who may prove to be most crucial in successfully managing the practical implementation of CA service contracts, the Service Contract Manager.

A description of the Naval Facilities Engineering Command requirements for this person was presented in the preceding section. Some additional requirements of the SCM are discussed.

A quality control manager must be able to investigate and prepare plans to meet long range quality control needs, establishing realistic objectives. He audits the effectiveness of in-house quality control procedures and spot-checks delivered services to measure quality. He must be able to analyze and interpret records resulting from a quality assurance program, and be able to quickly dispose of matters pertaining to defective performance.

He develops standard procedures for random sampling inspections and for collection, tabulation, and reporting of results to proper authorities. He assists in surveys of quality control techniques utilized by potential suppliers. He conducts quality assurance training courses. He maintains cognizance of all current industrial quality control standards, and may research and develop new quality assurance techniques. [Ref. 30]

Most Public Works Commercial Activities fall into one of four general categories. Service Contract Managers should have general knowledge of these categories which are:

a) General Housekeeping Services:
   i) Custodial services;
   ii) Refuse services; and
   iii) Grounds maintenance services.
b) Building and Maintenance Sevices:
   i) Housing maintenance services;and
   ii) Industrial facility maintenance services.
c) Transportation Equipment Operations and Maintenance services; and
d) Utilities Operations and Maintenance services.

When functions are placed under cost study, these will indicate the technical and managerial skills to be required of Service Contract Managers and Quality Assurance Evaluators. Possible job series desriptors for the Service Contract Manager will be explored which might match technical and managerial capabilities required for this important activity position. Specific job series descriptions or Wage Grade classifications for Quality Assurance Evaluators will not be evaluated in the thesis due to the diversity of activity requirements for these positions.

The primary consideration in choosing Quality Assurance Evaluators is determining if there will be a paramount requirement for actual trade or craft experience. If the inspection duties requires that QAE's be able to perform the work, then a Wage Grade classification is required. Otherwise, a General Schedule job description will suffice.

Civilian personnel offices are most qualified to determine the classifications and grades for QAE billets. It is imperative that the activity carefully define inspection work requirements so that an accurate assessment of specific technical and managerial skills can be determined. These will be the basis of the position description that will be used to evaluate the qualifications and prior experience of a prospective QAE candidate. The Service Contract Manager should be involved in the initial screening of such candidates.

When the Service Contract Manager role was first defined by NAVFAC, it was recommended that this position be classifed under the GS-1102 series, Contract Specialist. This series primarily involves the review and control over contracts to protect the government's interest based upon business, financial, and legal standpoints. This series is suitable if the activity desires greater emphais on maintaining the integrity of its service contracts. It does not address technical knowledge requirements which may be necessary to manage diverse types of industrial functions.

Another job series that has been suggested is the GS-809 series, Construction Control Inspector. Representative functions of this classification are listed: [Ref. 48]

a) Reviews of plans and specifications prior to contract solicitation;
b) attends pre-bid and pre-construction conferences;
c) supervises conduct of site surveys;

d) assists in development of specifications;

e) interfaces with contractors; furnishes requirements for construction scheduling, progress reporting, safety measures, wage and hour law requirements;

f) observes and identifies all stages of construction, and takes action to correct problems;

g) reviews contractor inspection systems and advises of necessary corrections;

h) investigates and processes change orders; and

i) interfaces with local agencies and authorities during construction.

The GS-809 series places significant emphasis on technical skill requirements, some emphasis on knowledge of contracting skills, and minimal emphasis on managerial capabilities. This position has been used with success for supervisory construction inspection positions. It would be most suitable for quality assurance specialists or for Service Contract Managers who will be responsible for surveillance of maintenance construction service contracts.

Another series is the GS-810 Facilities Engineering Manager. It covers duties in the areas of investigations and surveys, planning and design, construction, research, and facilities engineering management. Generally speaking, the GS-810 series does not reflect a substantial requirement for directive or supervisory control and may not be a most suitable choice. It also lacks a requirement for general knowledge of contract administration procedures. [Ref. 49]

Another alternative is the GS-1640, series, Facilities Manager, which reflects a requirement for broad technical knowledge of operating capabilities and maintenance requirements for an activitiy's various types of physical plant and equipment. Certain specific elements of job performance include maintenance program planning, financial planning and control, and facilities requirements planning. This posi-

tion's shortcoming is that it omits a requirement for general knowledge of contract procedures. [Ref. 50]

All series discussed thus far lack a requirement for knowledge in one area that is important for the future development of CA service contracting, knowledge of statistical quality assurance techniques. This has not been mentioned in the preceding job series although it is essential if new sampling inspection systems recommended by A-76 policy are to be implemented.

A job series that might best integrate the areas of quality assurance, contract administration knowledge, and limited technical and managerial expertise is the GS-1910 series, Quality Assurance Inspector. It addresses the design and administration of quality assurance systems that involve monitoring, controlling and maintaining quality and reliability for delivered goods and services. Specific job elements include:

a) Review of the contractor's performance,

b) review and acceptance of contractor quality control systems,

c) inspection of delivered services to verify a contractor's stated quality of services,

d) use of random sampling techniques in service contract surveillance,

e) summarization and analysis of results of inspections of services, and

f) resolution of contractor quality problems.

The Air Force has utilized the GS-1910 series for its Quality Assurance Program Coordinator positions at the field activity level. The coordinator conducts training of all functional quality assurance evaluators and also assists in the statement of work and quality assurance plan development processes. He conducts audits of ongoing quality assurance

and quality control procedures for all Air Force field activity contracts. He may participate in progress meetings that are held with contractors. Working in conjunction with cognizant contract administrators as well as the functional area's Quality Assurance Evaluator, he is a vital part of the activity's service contract program. The Navy Service Contract Manager would perform essentially the same roles, except that this role is expanded to include direct supervision of QAE's.

Use of the GS-1910 series is recommended as the most suitable position description for Service Contract Managers. Additional training in contract administration procedures may be required, but this can be easily accomodated by sending the SCM to a contracting school (such as the Civil Engineer Corps Officers School at Port Hueneme, California.) This position is operational in nature, and requires a working knowledge of various statistical quality assurance techniques. It is unlikely any of the previously mentioned job series will enable the activity to secure a manager with this specialized background. An industrial engineering background for prospective SCM candidates is also recommended.

The rest of the inspection organization can supplement and augment the general knowledge held by the Service Contract Manager. Quality Assurance Evaluators should possess special skills in carpentry, utility equipment, transportation vehicle equipment and other specialized skill requirements. Based on preceding discussions of organizational issues, the hiring of contract specialists may be necessitated. Such skill and technical knowledge requirements will be influenced by the size of a naval activity, its complexity, and the number of service contracts that are being performed. It may be necessary to hire statistical specialists at either intermediate or top level commands so that ongoing review and improvement of statistical surveillance methods can be carried out.

Activities must accurately determine the qualifications of the Sevice Contract Manager, especially if they elect to form a centralized service contract management organization. The ability to successfully execute Commercial Activities will be tied to the skills of the SCM and his organization.

D. SUMMARY

This chapter has examined several issues that relate to the creation of an inspection organization for those service contracts that result from OMB Circular A-76 implementation. The Navy field activity that receives services has the major responsibility for ensuring proper contract administration by providing on-site surveillance resources.

The activity must follow a sequence of actions that lead to the creation of an onsite inspection organization. It must first estimate how many inspectors it will need, making plans to hire additional inspectors or utilize existing personnel resources.

It must ensure that a training program is established which educates the inspectors in quality assurance procedures and furthers their knowledge in contract administration principles. It must secure funding for this effort.

The activity must choose the organization format that best suits its surveillance needs. Although research suggests that a centralized format is preferable, the activity may elect to place inspectors under functional managers. Either system must offer sufficient management control to ensure that contractual integrity is established.

Finally, based upon the type of contracts to be awarded, an activity must define knowledge and skill requirements for the Quality Assurance Evaluators and Service Contract Managers. The SCM position is vitally important, and a most capable individual with training in statistical quality control techniques is required.

With a proper integration of each of these activities, Navy activities can expect to be in control of the evolution and proper implementation of OMB Circular A-76.

VII. RECOMMENDATIONS FOR IMPROVEMENTS IN CA CONTRACT CONVERSIONS

A. IMPROVEMENTS IN STATISTICAL QUALITY ASSURANCE

It is evident that quality assurance techniques are useful and beneficial in the CA service contract process, promoting fairness and equity to all concerned parties when used properly. These techniques should ultimately reduce contract costs to the government and contractors, and lead to more reliable assessment and documentation of service contract quality. Statistical Quality Control (SQC) applications will be limited only by the creativity and imagination of those who use them.

Accordingly, the following recommendations for the quality assurance process are offered.A formal working panel of DOD officials should be organized to review the different statistical quality assurance methods that are either being utilized or being studied. Accurate, reliable information that examines the merits and weaknesses of acceptance and estimation sampling processes should be made available to this panel. Perhaps an independent, unbiased, quality control expert should be included on this panel to ensure that each member properly understands the validity and application of statistical quality assurance to CA service contracts. The authors believe that any confusion among various DOD CA management officials concerning SQC techniques can be eliminated by properly and accurately stating which of these can be used in ongoing A-76 contracts.

A cost-benefit and risk analysis may be conducted to examine which of the two sampling processes are more appropriate for CA quality assurance. Fixed budgetary funding

amounts for CA contract administration may have significant influence in the determination of which standard system should be adopted.

B. IMPROVEMENTS IN ADMINISTERING EXTRAPOLATED DEDUCTIONS

A uniform policy should also be adopted for the extrapolated deductions process. As was observed earlier, the Air Force does not deduct for defects when these are less than the reject number at the specified acceptable quality level (AQL). New NAVFAC policy, if adopted, would call for deductions for all observed defects and liquidated damages set as a percentage of the value of each observed defective work item. Current Air Force and proposed NAVFAC policy would implement extrapolated deductions from samples to lots when specified AQL's are exceeded.

The authors believe that the NAVFAC policy should be adopted. It is more realistic, providing more enforcement power in the long range evolution of CA service contracting. It may also be more defensible in subsequent GAO and other DOD audits of each agency's CA contract administration efforts. The previously mentioned DOD A-76 working panel that studies sampling techniques should be tasked to resolve this divergence in administration policy.

The authors recommend an immediate resolution of this issue to allow the presentation to its contractor community of one uniform DOD CA policy concerning contract deductions and inspection. Failure to do so will hinder optimal performance of government surveillance, and possibly cause it to become ineffective.

C. IMPROVEMENTS IN ESTIMATING INSPECTION RESOURCES

The first major issue that was covered in this topic area was the proper estimation of contract administration resources, particularly the determination of the required number of Quality Assurance Evaluators. If a policy is adopted that attempts to correlate the number of required inspectors with the number of contracts, their dollar value, or the number of positions being converted, then a comprehensive study should be undertaken of A-76 resource expenditures by all federal agencies and activities to facilitate the development of an estimating model. All facets of CA service contract administration resources consumed for the past five to ten years will need to be carefully examined; such a large inclusive data base will be the most reliable means of building this model; however, the cost and time requirements for its development may be prohibitive.

The authors recommend a much simpler and more accurate approach similar to that which was developed by the Atlantic Division, Naval Facilities Engineering Command. This model, when used properly, should provide a relatively unbiased and unconstrained estimate of resource requirements. If this technique is used, sincere attempts must be made by all federal agencies to procure and place the required inspection resources at each field activity. A careful integration of A-76 resource planning activities in each agency's annual budget process will be required.

If suboptimization or satisficing occur in this process, then the first, more detailed, model should be developed since it will probably be more indicative of actual inspection requirements.

D. ENHANCEMENT OF CURRENT QAE TRAINING

During the course of the study research, the authors observed different training programs for Quality Assurance Evaluators. In general, these were sufficient in providing initial exposure to rudiments of contract law, sampling techniques, and other skill areas required of QAE's. These basic training courses should be enhanced by instituting more ongoing activity training programs which either reiterate or augment the fundamental precepts of CA service contract administration and, in turn, lead to a more professional QAE staff.

The Air Force has addressed this need in designing its QAE training programs. The QA Program Coordinator maintains a continuing dialogue with each QAE during the performance periods of service contracts, with contract administrators also offering their advice and assistance.

The Navy has adopted the practice of offering regionalized training for QAE's at either Engineering Field Divisions, large Public Works Departments, or Public Works Centers. QAE candidates travel to these sites and spend a week in training. Few ongoing training programs at the activity level were observed.

The authors recommend that existing agency efforts in the training phase of CA implementation be continued. Improvements should be effected in creating more ongoing activity training programs, perhaps adopting a programmed learning type of instruction technique. Training in statistical quality assurance can be improved further, with a greater emphasis placed on basic statistical theory and application .

Funding support for QAE training is crucial to enable the quality assurance programs for CA service contracts to be successful. Haphazard and poorly planned funding will

jeopardize the enrichment of skills of each QAE and possibly detract from the successful evolution of the A-76 program.

E. FACILITATING CA ADMINISTRATION CONTROL THROUGH CENTRALIZATION

A large portion of the study addressed the creation of centralized CA contract administration organizations. It is realized that this organizational form will not be appropriate for all DOD agencies and activities given a wide diversity in size and mission requirements; many activities may be reluctant to embrace this format even where it is proven to be feasible and appropriate. Earlier discussion, however, indicated that the advantages of centralization outweigh the disadvantages.

This structure also has the advantage of gaining immediate management control and integrity of CA contract administration in the current developmental stages of A-76 implementation. Congressional oversight and public opinion will be very critical of cost overruns and contract irregularities, especially if a large number of displaced federal employees voice their objections. Decentralized control is not guaranteed to result in such abuses, but it would invite their occurence more readily than will centralized inspection organziations.Centralized inspection will more readily facilitate coordinated inspector efforts than decentralized formats. The credibility of inspection efforts may be enhanced more with centralized organizations.

Additional reasons for supporting creation of centralized organizations are that full costs of inspection may be reduced, training programs may be more effectively administered, and lines of communication from government representatives to contract administrators will be made more clear. The authors recommend that the centralized organization structure be adopted.

F. SERVICE CONTRACT MANAGER QUALIFICATIONS

The Service Contract Manager will be a key activity individual whether centralized or decentralized organizations are chosen. He should be well versed in statistical sampling and have a broad general background in contract administration principles, as well as having some knowledge of the functional areas to be contracted out. The authors recommend use of the GS-1910 series, as it offers the most versitality and flexibility in overseeing CA service contract administration. Other job descriptions were examined, and in fact, some of these have actually been utilized by various Navy activities. For example, the GS-1102 series could be utilized despite its lack of technical knowledge requirements. The overriding necessity for knowledge of SQC techniques and their applications should lead to uniform acceptance of the GS-1910 series as a CA contract administration manager standard.

G. FUTURE CA QUALITY ASSURANCE IMPROVEMENTS

In its Command Management Guidance for fiscal years 1984 to 1990, NAVFAC headquarters stresses the attainment of "most efficient organization" (MEO) structure by all of its activities. This thesis examined initiatives in the development of quality assurance programs which should lead to such cost economies while achieving required levels of service. These should also improve the professionalism exhibited by federal agencies in executing further Commercial Activities contracts.

Comprehensive planning efforts should be initiated at all Navy organization levels to develop an effective A-76 implementation strategy, and integrate contract design with quality assurance. Other Navy Systems Commands besides NAVFAC are responsible for a substantial number of

Commercial Activities subject to OMB Circular A-76. These commands should follow NAVFAC's lead in executing their own CA programs.

Continued pursuit of the A-76 policy will change the character of mission performance. DOD agencies will need to carefully plan for their administration of service contract programs to preclude deterioration in the quality of the services they receive.

APPENDIX A

LEGISLATIVE PROVISIONS

The following are excerpts from two Public Laws that establish congressional policy and recurring restrictions concerning the conversion of DOD In-house activities to contract performance.

Department of Defense Appropriation Authorization Act, 1975, Public Law 93-365, August 5, 1974

> SEC. 502. It is the sense of Congress that the Department of Defense shall use the least costly form of manpower that is consistent with military requirements and other needs of the Department of Defense. Therefore, in developing the annual manpower authorization requests to the Congress and in carrying out manpower policies, the Secretary of Defense shall, in particular, consider the advantages of converting from one form of manpower to another (military, civilian, or private contract) for the performance of a specified job. A full justification of any conversion from one form of manpower to another shall be contained in the annual manpower requirements report to the Congress required by section 138(c)(3) of title 10, United States Code.

Department of Defense Authorization Act, 1981, Public Law 96-342, September 8, 1980

SEC. 502.

a) No commercial or industrial type function of the Department of Defense that on October 1, 1980, is being performed by Department of Defense personnel may be converted to performance by a private contractor--

i) to circumvent any civilian personnel ceiling; or

ii) unless the Secretary of Defense provides to the Congress in a timely manner--

1. notification of any decision to study such commercial or industrial type function for possible performance by a private contractor;

2. a detailed summary of a comparison of the cost of performance of such function by Department of Defense personnel and by private contractor which demonstrates that the performance of such function by a private contractor will result in a cost savings to the Government over the life of the contract and a certification that the entire cost comparison is available;

3. a certification that the Government calculation for the cost of performance of such function by Department of Defense personnel is based on an estimate of the most efficient and cost effective organization for performance of such function by Department of Defense personnel; and

4. a report, to be submitted with the certification required by subparagraph 3, showing-- the potential economic effect on employees affected, and the potential economic effect on the local community and Federal Government if more than 50 employees are involved, of contracting for performance of such function; the effect of contracting for performance of such function on the military mission of such function; and the amount of the bid accepted for the performance of such function by the private contractor whose bid is accepted and the cost of performance of such function by Department of Defense personnel, together with costs and expenditures which the Government will incur because of the contract.

b) If, after completion of the studies required for completion of the certification and report required by subparagraphs 3 and 4 of subsection aii), a decision is made to convert to contractor performance, the Secretary of Defense shall notify Congress of such decision.

c) The Secretary of Defense shall submit a written report to the Congress by February 1 of each fiscal year describing the extent to which commercial and industrial type functions were performed by Department of Defense contractors during the preceding fiscal year. The Secretary shall include in each such report an estimate of the percentage of commercial and industrial type functions of the Department of Defense that will be performed by Department of Defense personnel, and the percentage of such functions that will be performed by private contractors, during the fiscal year during which the report is submitted.

d) This section shall take effect on October 1, 1980.

APPENDIX B

EXCERPTS FROM MIL-STD-105D AND MIL-HNDBK-53-1A

In this appendix, information contained in both Military Standard 105D and Military Handbook 53-1A is presented. The text of MIL-STD-105D is given in pages 111 through 120. Key issues to be considered in the use of the standard are the lot size, the inspection intensity, and the desired acceptable quality level (AQL). A determination of these variables results in a sampling size and accept/reject numbers. Operating characteristic (OC) curves for various sampling plans are also presented in pages 121 through 127. These represent the protection that is offered to both the contractor and the government, being a function of the percent of defectives that are found in samples.

Pages 128 through 131 are selected pages from MIL-HNDBK-53-1A which provide more detailed explanations of the operating characteristic curves. Page 132 is an excerpt from a random number table. Finally, pages 133 and 134 are a listing of key activities to be followed in implementing MIL-STD-105D.

SAMPLING PROCEDURES AND TABLES FOR INSPECTION BY ATTRIBUTES

1. SCOPE

1.1 PURPOSE. This publication establishes sampling plans and procedures for inspection by attributes. When specified by the responsible authority, this publication shall be referenced in the specification, contract, inspection instructions, or other documents and the provisions set forth herein shall govern. The "responsible authority" shall be designated in one of the above documents.

1.2 APPLICATION. Sampling plans designated in this publication are applicable, but not limited, to inspection of the following:

a. End items.

b. Components and raw materials.

c. Operations.

d. Materials in process.

e. Supplies in storage.

f. Maintenance operations.

g. Data or records.

h. Administrative procedures.

These plans are intended primarily to be used for a continuing series of lots or batches. The plans may also be used for the inspection of isolated lots or batches, but, in this latter case, the user is cautioned to consult the operating characteristic curves to find a plan which will yield the desired protection (see 11.6).

1.3 INSPECTION. Inspection is the process of measuring, examining, testing, or otherwise comparing the unit of product (see 1.5) with the requirements.

1.4 INSPECTION BY ATTRIBUTES. Inspection by attributes is inspection whereby either the unit of product is classified simply as defective or nondefective, or the number of defects in the unit of product is counted, with respect to a given requirement or set of requirements.

1.5 UNIT OF PRODUCT. The unit of product is the thing inspected in order to determine its classification as defective or nondefective or to count the number of defects. It may be a single article, a pair, a set, a length, an area, an operation, a volume, a component of an end product, or the end product itself. The unit of product may or may not be the same as the unit of purchase, supply, production, or shipment.

2. CLASSIFICATION OF DEFECTS AND DEFECTIVES

2.1 METHOD OF CLASSIFYING DEFECTS. A classification of defects is the enumeration of possible defects of the unit of product classified according to their seriousness. A defect is any nonconformance of the unit of product with specified requirements. Defects will normally be grouped into one or more of the following classes; however, defects may be grouped into other classes, or into subclasses within these classes.

2.1.1 CRITICAL DEFECT. A critical defect is a defect that judgment and experience indicate is likely to result in hazardous or unsafe conditions for individuals using, maintaining, or depending upon the product; or a defect that judgment and experience indicate is likely to prevent performance of the tactical function of a major end item such as a ship, aircraft, tank, missile or space vehicle. NOTE: For a special provision relating to critical defects, see 6.3.

2.1.2 MAJOR DEFECT. A major defect is a defect, other than critical, that is likely to result in failure, or to reduce materially the usability of the unit of product for its intended purpose.

2.1.3 MINOR DEFECT. A minor defect is a defect that is not likely to reduce materially the usability of the unit of product for its intended purpose, or is a departure from established standards having little bearing on the effective use or operation of the unit.

2.2 METHOD OF CLASSIFYING DEFECTIVES. A defective is a unit of product which contains one or more defects. Defectives will usually be classified as follows:

2.2.1 CRITICAL DEFECTIVE. A critical defective contains one or more critical defects and may also contain major and or minor defects. NOTE: For a special provision relating to critical defectives, see 6.3.

2.2.2 MAJOR DEFECTIVE. A major defective contains one or more major defects, and may also contain minor defects but contains no critical defect.

2.2.3 MINOR DEFECTIVE. A minor defective contains one or more minor defects but contains no critical or major defect.

3. PERCENT DEFECTIVE AND DEFECTS PER HUNDRED UNITS

3.1 EXPRESSION OF NONCONFORMANCE. The extent of nonconformance of product shall be expressed either in terms of percent defective or in terms of defects per hundred units.

3.2 PERCENT DEFECTIVE. The percent defective of any given quantity of units of product is one hunderd times the number of defective units of product contained therein divided by the total number of units of product, i.e.:

$$\text{Percent defective} = \frac{\text{Number of defectives}}{\text{Number of units inspected}} \times 100$$

3.3 DEFECTS PER HUNDRED UNITS. The number of defects per hundred units of any given quantity of units of product is one hundred times the number of defects contained therein (one or more defects being possible in any unit of product) divided by the total number of units of product, i.e.:

$$\text{Defects per hundred units} = \frac{\text{Number of defects}}{\text{Number of units inspected}} \times 100$$

4. ACCEPTABLE QUALITY LEVEL (AQL)

4.1 USE. The AQL, together with the Sample Size Code Letter, is used for indexing the sampling plans provided herein.

4.2 DEFINITION. The AQL is the maximum percent defective (or the maximum number of defects per hundred units) that, for purposes of sampling inspection, can be considered satisfactory as a process average (see 11.2).

4.3 NOTE ON THE MEANING OF AQL. When a consumer designates some specific value of AQL for a certain defect or group of defects, he indicates to the supplier that his (the consumer's) acceptance sampling plan will accept the great majority of the lots or batches that the supplier submits, provided the process average level of percent defective (or defects per hundred units) in these lots or batches be no greater than the designated value of AQL. Thus, the AQL is a designated value of percent defective (or defects per hundred units) that the consumer indicates will be accepted most of the time by the acceptance sampling procedure to be used. The sampling plans provided herein are so arranged that the probability of acceptance at the designated AQL value depends upon the sample size, being generally higher for large samples than for small ones, for a given AQL. The AQL alone does not describe the protection to the consumer for individual lots or batches but more directly relates to what might be expected from a series of lots or batches, provided the steps indicated in this publication are taken. It is necessary to refer to the operating characteristic curve of the plan, to determine what protection the consumer will have.

4.4 LIMITATION. The designation of an AQL shall not imply that the supplier has the right to supply knowingly any defective unit of product.

4.5 SPECIFYING AQLs. The AQL to be used will be designated in the contract or by the responsible authority. Different AQLs may be designated for groups of defects considered collectively, or for individual defects. An AQL for a group of defects may be designated in addition to AQLs for individual defects, or subgroups, within that group. AQL values of 10.0 or less may be expressed either in percent defective or in defects per hundred units; those over 10.0 shall be expressed in defects per hundred units only.

4.6 PREFERRED AQLs. The values of AQLs given in these tables are known as preferred AQLs. If, for any product, an AQL be designated other than a preferred AQL, these tables are not applicable.

5. SUBMISSION OF PRODUCT

5.1 LOT OR BATCH. The term lot or batch shall mean "inspection lot" or "inspection batch," i.e., a collection of units of product from which a sample is to be drawn and inspected to determine conformance with the acceptability criteria, and may differ from a collection of units designated as a lot or batch for other purposes (e.g., production, shipment, etc.).

5.2 FORMATION OF LOTS OR BATCHES. The product shall be assembled into identifiable lots, sublots, batches, or in such other manner as may be prescribed (see 5.4). Each lot or batch shall, as far as is practicable,

consist of units of product of a single type, grade, class, size, and composition, manufactured under essentially the same conditions, and at essentially the same time.

5.3 LOT OR BATCH SIZE. The lot or batch size is the number of units of product in a lot or batch.

5.4 PRESENTATION OF LOTS OR BATCHES. The formation of the lots or batches, lot or batch size, and the manner in which each lot or batch is to be presented and identified by the supplier shall be designated or approved by the responsible authority. As necessary, the supplier shall provide adequate and suitable storage space for each lot or batch, equipment needed for proper identification and presentation, and personnel for all handling of product required for drawing of samples.

6. ACCEPTANCE AND REJECTION

6.1 ACCEPTABILITY OF LOTS OR BATCHES. Acceptability of a lot or batch will be determined by the use of a sampling plan or plans associated with the designated AQL or AQLs.

6.2 DEFECTIVE UNITS. The right is reserved to reject any unit of product found defective during inspection whether that unit of product forms part of a sample or not, and whether the lot or batch as a whole is accepted or rejected. Rejected units may be repaired or corrected and resubmitted for inspection with the approval of, and in the manner specified by, the responsible authority.

6.3 SPECIAL RESERVATION FOR CRITICAL DEFECTS. The supplier may be required at the discretion of the responsible authority to inspect every unit of the lot or batch for critical defects. The right is reserved to inspect every unit submitted by the supplier for critical defects, and to reject the lot or batch immediately, when a critical defect is found. The right is reserved also to sample, for critical defects, every lot or batch submitted by the supplier and to reject any lot or batch if a sample drawn therefrom is found to contain one or more critical defects.

6.4 RESUBMITTED LOTS OR BATCHES. Lots or batches found unacceptable shall be resubmitted for reinspection only after all units are re-examined or retested and all defective units are removed or defects corrected. The responsible authority shall determine whether normal or tightened inspection shall be used, and whether reinspection shall include all types or classes of defects or for the particular types or classes of defects which caused initial rejection.

7. DRAWING OF SAMPLES

7.1 SAMPLE. A sample consists of one or more units of product drawn from a lot or batch, the units of the sample being selected at random without regard to their quality. The number of units of product in the sample is the sample size.

7.2 REPRESENTATIVE SAMPLING. When appropriate, the number of units in the sample shall be selected in proportion to the size of sublots or subbatches, or parts of the lot or batch, identified by some rational criterion.

7. DRAWING OF SAMPLES (Continued)

When representative sampling is used, the units from each part of the lot or batch shall be selected at random.

7.3 TIME OF SAMPLING. Samples may be drawn after all the units comprising the lot or batch have been assembled, or samples may be drawn during assembly of the lot or batch.

7.4 DOUBLE OR MULTIPLE SAMPLING. When double or multiple sampling is to be used, each sample shall be selected over the entire lot or batch.

8. NORMAL, TIGHTENED AND REDUCED INSPECTION

8.1 INITIATION OF INSPECTION. Normal inspection will be used at the start of inspection unless otherwise directed by the responsible authority.

8.2 CONTINUATION OF INSPECTION. Normal, tightened or reduced inspection shall continue unchanged for each class of defects or defectives on successive lots or batchs except where the switching procedures given below require change. The switching procedures given below require a change. The switching procedures shall be applied to each class of defects or defectives, independently.

8.3 SWITCHING PROCEDURES.

8.3.1 NORMAL TO TIGHTENED. When normal inspection is in effect, tightened inspection shall be instituted when 2 out of 5 consecutive lots or batches have been rejected on original inspection (i.e., ignoring resubmitted lots or batches for this procedure).

8.3.2 TIGHTENED TO NORMAL. When tightened inspection is in effect, normal inspection shall be instituted when 5 consecutive lots or batches have been considered acceptable on original inspection.

8.3.3 NORMAL TO REDUCED. When normal inspection is in effect, reduced inspection shall be instituted providing that all of the following conditions are satisfied:

a. The preceding 10 lots or batches (or more, as indicated by the note to Table VIII) have been on normal inspection and none has been rejected on original inspection; and

b. The total number of defectives (or defects) in the samples from the preceding 10 lots or batches (or such other number as was used for condition "a" above) is equal to or less than the applicable number given in Table VIII. If double or multiple sampling is in use, all samples inspected should be included, not "first" samples only; and

c. Production is at a steady rate; and

d. Reduced inspection is considered desirable by the responsible authority.

8.3.4 REDUCED TO NORMAL. When reduced inspection is in effect, normal inspection shall be instituted if any of the following occur on original inspection:

a. A lot or batch is rejected; or

b. A lot or batch is considered acceptable under the procedures of 10.1.4; or

c. Production becomes irregular or delayed; or

d. Other conditions warrant that normal inspection shall be instituted.

8.4 DISCONTINUATION OF INSPECTION. In the event that 10 consecutive lots or batches remain on tightened inspection (or such other number as may be designated by the responsible authority), inspection under the provisions of this document should be discontinued pending action to improve the quality of submitted material.

9. SAMPLING PLANS

9.1 SAMPLING PLAN. A sampling plan indicates the number of units of product from each lot or batch which are to be inspected (sample size or series of sample sizes) and the criteria for determining the acceptability of the lot or batch (acceptance and rejection numbers).

9.2 INSPECTION LEVEL. The inspection level determines the relationship between the lot or batch size and the sample size. The inspection level to be used for any particular requirement will be prescribed by the responsible authority. Three inspection levels: I, II, and III, are given in Table I for general use. Unless otherwise specified, Inspection Level II will be used. However, Inspection Level I may be specified when less discrimination is needed, or Level III may be specified for greater discrimination. Four additional special levels: S–1, S–2, S–3 and S–4, are given in the same table and may be used where relatively small sample sizes are necessary and large sampling risks can or must be tolerated.

NOTE: In the designation of inspection levels S–1 to S–4, care must be exercised to avoid AQLs inconsistent with these inspection levels.

9.3 CODE LETTERS. Sample sizes are designated by code letters. Table I shall be used to find the applicable code letter for the particular lot or batch size and the prescribed inspection level.

9.4 OBTAINING SAMPLING PLAN. The AQL and the code letter shall be used to obtain the sampling plan from Tables II, III or IV. When no sampling plan is available for a given combination of AQL and code letter, the tables direct the user to a different letter. The sample size to be used is given by the new code letter not by the original letter. If this procedure leads to different sample sizes for different classes of defects, the code letter corresponding to the largest sample size derived may be used for all classes of defects when designated or approved by the responsible authority. As an alternative to a single sampling plan with an acceptance number of 0, the plan with an acceptance number of 1 with its correspondingly larger sample size for a designated AQL (where available), may be used when designated or approved by the responsible authority.

9.5 TYPES OF SAMPLING PLANS. Three types of sampling plans: Single, Double and Multiple, are given in Tables II, III and IV, respectively. When several types of plans are available for a given AQL and code letter, any one may be used. A decision as to type of plan, either single, double, or multiple, when available for a given AQL and code letter, will usually be based upon the comparison between the administrative difficulty and the average sample sizes of the available plans. The average sample size of multiple plans is less than for double (except in the case corresponding to single acceptance number 1) and both of these are always less than a single sample size. Usually the administrative difficulty for single sampling and the cost per unit of the sample are less than for double or multiple.

10. DETERMINATION OF ACCEPTABILITY

10.1 PERCENT DEFECTIVE INSPECTION. To determine acceptability of a lot or batch under percent defective inspection, the applicable sampling plan shall be used in accordance with 10.1.1, 10.1.2, 10.1.3, 10.1.4, and 10.1.5.

10.1.1 SINGLE SAMPLING PLAN. The number of sample units inspected shall be equal to the sample size given by the plan. If the number of defectives found in the sample is equal to or less than the acceptance number, the lot or batch shall be considered acceptable. If the number of defectives is equal to or greater than the rejection number, the lot or batch shall be rejected.

10.1.2 DOUBLE SAMPLING PLAN. The number of sample units inspected shall be equal to the first sample size given by the plan. If the number of defectives found in the first sample is equal to or less than the first acceptance number, the lot or batch shall be considered acceptable. If the number of defectives found in the first sample is equal to or greater than the first rejection number, the lot or batch shall be rejected. If the number of defectives found in the first sample is between the first acceptance and rejection numbers, a second sample of the size given by the plan shall be inspected. The number of defectives found in the first and second samples shall be accumulated. If the cumulative number of defectives is equal to or less than the second acceptance number, the lot or batch shall be considered acceptable. If the cumulative number of defectives is equal to or greater than the second rejection number, the lot or batch shall be rejected.

10.1.3 MULTIPLE SAMPLE PLAN. Under multiple sampling, the procedure shall be similar to that specified in 10.1.2, except that the number of successive samples required to reach a decision may be more than two.

10.1.4 SPECIAL PROCEDURE FOR REDUCED INSPECTION. Under reduced inspection, the sampling procedure may terminate without either acceptance or rejection criteria having been met. In these circumstances, the lot or batch will be considered acceptable, but normal inspection will be reinstated starting with the next lot or batch (see 8.3.4 (b)).

10.2 DEFECTS PER HUNDRED UNITS INSPECTION. To determine the acceptability of a lot or batch under Defects per Hundred Units inspection, the procedure specified for Percent Defective inspection above shall be used, except that the word "defects" shall be substituted for "defectives."

11. SUPPLEMENTARY INFORMATION

11.1 OPERATING CHARACTERISTIC CURVES. The operating characteristic curves for normal inspection, shown in Table X (pages 30–62), indicate the percentage of lots or batches which may be expected to be accepted under the various sampling plans for a given process quality. The curves shown are for single sampling; curves for double and multiple sampling are matched as closely as practicable. The O. C. curves shown for AQLs greater than 10.0 are based on the Poisson distribution and are applicable for defects per hundred units inspection; those for AQLs of 10.0 or less and sample sizes of 80 or less are based on the binomial distribution and are applicable for percent defec-

tive inspection; those for AQLs of 10.0 or less and sample sizes larger then 80 are based on the Poisson distribution and are applicable either for defects per hundred units inspection, or for percent defective inspection (the Poisson distribution being an adequate approximation to the binomial distribution under these conditions). Tabulated values, corresponding to selected values of probabilities of acceptance (P_a, in percent) are given for each of the curves shown, and, in addition, for tightened inspection, and for defects per hundred units for AQLs of 10.0 or less and sample sizes of 80 or less.

11.2 PROCESS AVERAGE. The process average is the average percent defective or average number of defects per hundred units (whichever is applicable) of product submitted by the supplier for original inspection. Original inspection is the first inspection of a particular quantity of product as distinguished from the inspection of product which has been resubmitted after prior rejection.

11.3 AVERAGE OUTGOING QUALITY (AOQ). The AOQ is the average quality of outgoing product including all accepted lots or batches, plus all rejected lots or batches after the rejected lots or batches have been effectively 100 percent inspected and all defectives replaced by nondefectives.

11.4 AVERAGE OUTGOING QUALITY LIMIT (AOQL). The AOQL is the maximum of the AOQs for all possible incoming qualities for a given acceptance sampling plan. AOQL values are given in Table V–A for each of the single sampling plans for normal inspection and in Table V–B for each of the single sampling plans for tightened inspection.

11.5 AVERAGE SAMPLE SIZE CURVES. Average sample size curves for double and multiple sampling are in Table IX. These show the average sample sizes which may be expected to occur under the various sampling plans for a given process quality. The curves assume no curtailment of inspection and are approximate to the extent that they are based upon the Poisson distribution, and that the sample sizes for double and multiple sampling are assumed to be 0.631n and 0.25n respectively, where n is the equivalent single sample size.

11.6 LIMITING QUALITY PROTECTION. The sampling plans and associated procedures given in this publication were designed for use where the units of product are produced in a continuing series of lots or batches over a period of time. However, if the lot or batch is of an isolated nature, it is desirable to limit the selection of sampling plans to those, associated with a designated AQL value, that provide not less than a specified limiting quality protection. Sampling plans for this purpose can be selected by choosing a Limiting Quality (LQ) and a consumer's risk to be associated with it. Tables VI and VII give values of LQ for the commonly used consumer's risks of 10 percent and 5 percent respectively. If a different value of consumer's risk is required, the O.C. curves and their tabulated values may be used. The concept of LQ may also be useful in specifying the AQL and Inspection Levels for a series of lots or batches, thus fixing minimum sample size where there is some reason for avoiding (with more than a given consumer's risk) more than a limiting proportion of defectives (or defects) in any single lot or batch.

TABLE I—*Sample size code letters*

(See 9.2 and 9.3)

Lot or batch size	Special inspection levels				General inspection levels		
	S-1	S-2	S-3	S-4	I	II	III
2 to 8	A	A	A	A	A	A	B
9 to 15	A	A	A	A	A	B	C
16 to 25	A	A	B	B	B	C	D
26 to 50	A	B	B	C	C	D	E
51 to 90	B	B	C	C	C	E	F
91 to 150	B	B	C	D	D	F	G
151 to 280	B	C	D	E	E	G	H
281 to 500	B	C	D	E	F	H	J
501 to 1200	C	C	E	F	G	J	K
1201 to 3200	C	D	E	G	H	K	L
3201 to 10000	C	D	F	G	J	L	M
10001 to 35000	C	D	F	H	K	M	N
35001 to 150000	D	E	G	J	L	N	P
150001 to 500000	D	E	G	J	M	P	Q
500001 and over	D	E	H	K	N	Q	R

TABLE II-A—Single sampling plans for normal inspection (Master table)

(See 9.4 and 9.5)

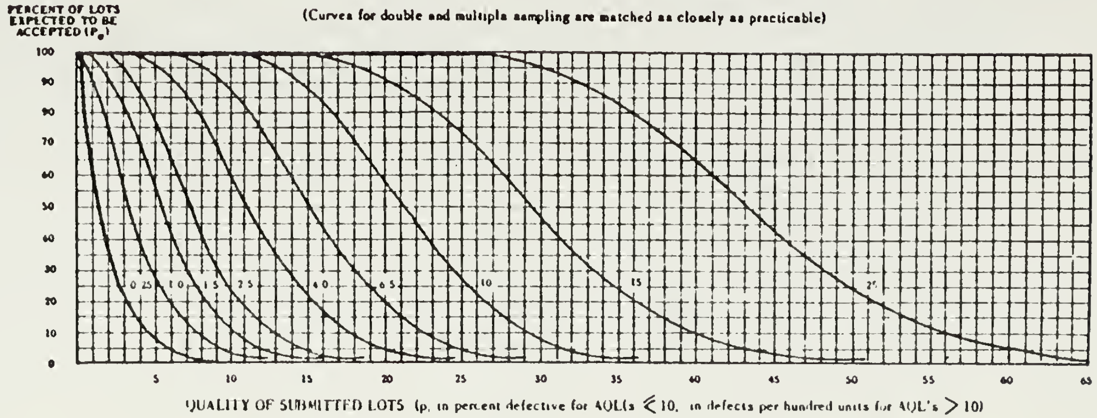
Sample size code letter	Sample size	Acceptable Quality Levels (normal inspection)																																																			
		0.010		0.015		0.025		0.040		0.065		0.10		0.15		0.25		0.40		0.65		1.0		1.5		2.5		4.0		6.5		10		15		25		40		65		100		150		250		400		650		1000	
		Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re
A	2	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇩		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	30	31
B	3	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	30	31	44	45
C	5	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	30	31	44	45	⇧	
D	8	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	30	31	44	45	⇧		⇧	
E	13	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	30	31	44	45	⇧		⇧		⇧	
F	20	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	⇧		⇧		⇧		⇧		⇧		⇧	
G	32	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	⇧		⇧		⇧		⇧		⇧		⇧		⇧	
H	50	⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
J	80	⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
K	125	⇩		⇩		⇩		⇩		⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
L	200	⇩		⇩		⇩		⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
M	315	⇩		⇩		⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
N	500	⇩		⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
P	800	⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
Q	1250	0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
R	2000	⇧		⇧		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	

⇩ = Use first sampling plan below arrow. If sample size equals, or exceeds, lot or batch size, do 100 percent inspection.
⇧ = Use first sampling plan above arrow.
Ac = Acceptance number.
Re = Rejection number.

TABLE X-H—Tables for sample size code letter: H

CHART H - OPERATING CHARACTERISTIC CURVES FOR SINGLE SAMPLING PLANS

(Curves for double and multiple sampling are matched as closely as practicable)



Note: Figures on curves are Acceptable Quality Levels (AQL's) for normal inspection

TABLE X-H-1 - TABULATED VALUES FOR OPERATING CHARACTERISTIC CURVES FOR SINGLE SAMPLING PLANS

P_a	Acceptable Quality Levels (normal inspection)																			
	0 25	1 0	1 5	2 5	4 0	6 5	X	10	0 25	1 0	1 5	2 5	4 0	6 5	X	10	X	15	X	25
	p (in percent defective)								p (in defects per hundred units)											
99 0	0 020	0 306	0 888	1 69	3 66	6 06	7 41	11 1	0 020	0 298	0 872	1 65	3 57	5 81	7 01	9 54	12 2	15 0	20 7	25 1
95 0	0 103	0 712	1 66	2 77	5 34	8 20	9 74	12 9	0 103	0 710	1 64	2 73	5 23	7 96	9 39	12 3	15 4	18 5	24 9	29 8
90 0	0 210	1 07	2 23	3 54	6 42	9 53	11 2	14 5	0 210	1 06	2 20	3 49	6 30	9 31	10 9	14 0	17 3	20 6	27 3	32 5
75 0	0 574	1 92	3 46	5 09	8 51	12 0	13 8	17 5	0 576	1 92	3 45	5 07	8 44	11 9	13 7	17 2	20 8	24 5	31 8	37 4
50 0	1 38	3 33	5 31	7 30	11 3	15 2	17 2	21 2	1 39	3 36	5 35	7 34	11 3	15 3	17 3	21 6	25 3	29 3	37 3	43 3
25 0	2 74	5 30	7.70	10 0	14 5	18 8	21 0	25 2	2 77	5 39	7 84	10 2	14 8	19 4	21 6	26 0	30 4	34 8	43 5	49 9
10 0	4 50	7 56	10 3	12 9	17 8	22 4	24 7	29 1	4 61	7 78	10 6	13 4	18 6	23 5	26 0	30 8	35 6	40 3	49 5	56 4
5 0	5 82	9 13	12 1	14 8	19 9	24 7	27 0	31 6	5 99	9 49	12 6	15 5	21 0	26 3	28 9	33 9	38 9	43 8	53 4	60 5
1 0	8 80	12 5	15 9	18 8	24 3	29 2	31 7	36 3	9 21	13 3	16 8	20 1	26 2	32 0	34 8	40 3	45 6	50 9	61 1	68 7
	0 40	1 5	2 5	4 0	6 5	X	10	X	0 40	1 5	2 5	4 0	6 5	X	10	X	15	X	25	X
	Acceptable Quality Levels (tightened inspection)																			

Note: Binomial distribution used for percent defective computations; Poisson for defects per hundred units.

TABLE X-H-2 - SAMPLING PLANS FOR SAMPLE SIZE CODE LETTER: H

Type of sampling plan	Cumulative sample size	Acceptable Quality Levels (normal inspection)																																		Cumulative sample size
		Less than 0.25		0.25		0.40		X		0.65		1.0		1.5		2.5		4.0		6.5		X		10		X		15		X		25		Higher than 25		
		Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	
Single	50	▽		0	1	Use Letter G		Use Letter K		Use Letter J		1	2	2	3	3	4	5	6	7	8	8	9	10	11	12	13	14	15	18	19	21	22	△		50
Double	32	▽		•								0	2	0	3	1	4	2	5	3	7	3	7	5	9	6	10	7	11	9	14	11	16	△		32
	64											1	2	3	4	4	5	6	7	8	9	11	12	12	13	15	16	18	19	23	24	26	27			64
Multiple	13	▽		•								*	2	*	2	*	3	*	4	0	4	0	4	0	5	0	6	1	7	1	8	2	9	△		13
	26											*	2	0	3	0	3	1	5	1	6	2	7	3	8	3	9	4	10	6	12	7	14			26
	39											0	2	0	3	1	4	2	6	3	8	4	9	6	10	7	12	8	13	11	17	13	19			39
	52											0	3	1	4	2	5	3	7	5	10	6	11	8	13	10	15	12	17	16	22	19	25			52
	65											1	3	2	4	3	6	5	8	7	11	9	12	11	15	14	17	17	20	22	25	25	29			65
	78											1	3	3	5	4	6	7	9	10	12	12	14	14	17	18	20	21	23	27	29	31	33			78
	91											2	3	4	5	6	7	9	10	13	14	14	15	18	19	21	22	25	26	32	33	37	38			91
		Less than 0.40		0.40		X		0.65		1.0		1.5		2.5		4.0		6.5		X		10		X		15		X		25		X		Higher than 25		
		Acceptable Quality Levels (tightened inspection)																																		

△ = Use next preceding sample size code letter for which acceptance and rejection numbers are available

▽ = Use next subsequent sample size code letter for which acceptance and rejection numbers are available

Ac = Acceptance number

Re = Rejection number

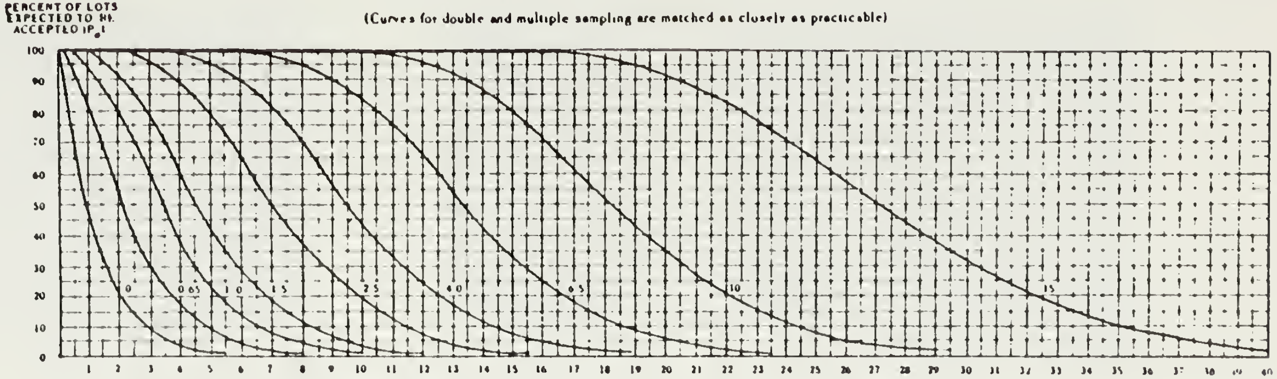
• = Use single sampling plan above (or alternatively use letter L).

* = Acceptance not permitted at this sample size

TABLE X-J—Tables for sample size code letter: J

CHART J - OPERATING CHARACTERISTIC CURVES FOR SINGLE SAMPLING PLANS

(Curves for double and multiple sampling are matched as closely as practicable)



QUALITY OF SUBMITTED LOTS (p, in percent defective for AQL's ≤10, in defects per hundred units for AQL's >10)

Note: Figures on curves are Acceptable Quality Levels (AQL's) for normal inspection

TABLE X-J-1 - TABULATED VALUES FOR OPERATING CHARACTERISTIC CURVES FOR SINGLE SAMPLING PLANS

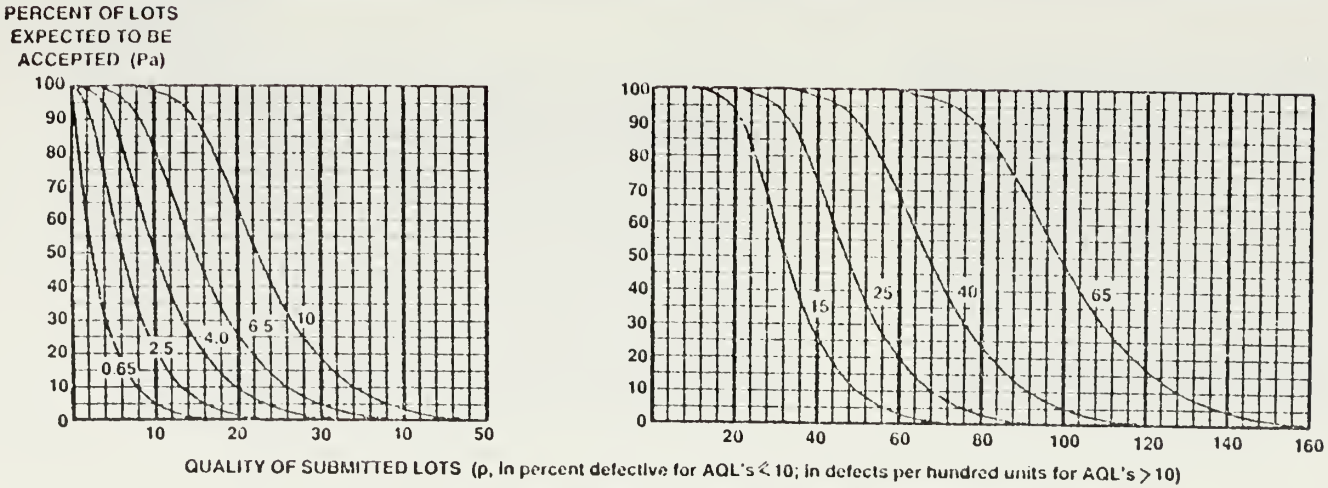
Pa	Acceptable Quality Levels (normal inspection)									
	0.15	0.65	1.0	1.5	2.5	4.0	X	6.5	X	10
	p (in percent defective)									
99.0	0.013	0.188	0.550	1.05	2.30	3.72	4.50	6.13	7.88	9.75
95.0	0.064	0.444	1.03	1.73	3.32	5.06	5.98	7.91	9.89	11.9
90.0	0.132	0.666	1.38	2.20	3.98	5.91	6.91	8.95	11.0	13.2
75.0	0.359	1.202	2.16	3.18	5.30	7.50	8.62	10.9	13.2	15.5
50.0	0.863	2.09	3.33	4.57	7.06	9.55	10.8	13.3	15.8	18.3
25.0	1.72	3.33	4.84	6.31	9.14	11.9	13.3	16.0	18.6	21.3
10.0	2.84	4.78	6.52	8.16	11.3	14.2	15.7	18.6	21.4	24.2
5.0	3.68	5.80	7.66	9.39	12.7	15.8	17.3	20.3	23.2	26.0
1.0	5.59	8.00	10.1	12.0	15.6	18.9	20.5	23.6	26.5	29.5
	0.25	1.0	1.5	2.5	4.0	X	6.5	X	10	X
	Acceptable Quality Levels (tightened inspection)									

Pa	Acceptable Quality Levels (normal inspection)											
	0.15	0.65	1.0	1.5	2.5	4.0	X	6.5	X	10	X	15
	p (in defects per hundred units)											
99.0	0.013	0.186	0.545	1.03	2.23	3.63	4.38	5.96	7.62	9.35	12.4	15.2
95.0	0.064	0.444	1.02	1.71	3.27	4.98	5.87	7.71	9.61	11.6	15.6	18.6
90.0	0.131	0.665	1.38	2.18	3.94	5.82	6.79	8.78	10.8	12.9	17.1	20.3
75.0	0.360	1.20	2.16	3.17	5.27	7.45	8.55	10.8	13.0	15.3	19.9	21.4
50.0	0.866	2.10	3.34	4.59	7.09	9.59	10.8	13.3	15.0	18.3	23.3	27.1
25.0	1.73	3.37	4.90	6.39	9.28	12.1	13.5	16.3	19.0	21.8	27.2	31.2
10.0	2.88	4.86	6.65	8.35	11.6	14.7	16.2	19.3	22.2	25.2	30.9	35.2
5.0	3.75	5.93	7.87	9.69	13.1	16.4	18.0	21.2	24.3	27.4	31.4	37.8
1.0	5.76	8.30	10.5	12.6	16.4	20.0	21.8	25.2	28.5	31.8	38.2	42.9
	0.25	1.0	1.5	2.5	4.0	X	6.5	X	10	X	15	X
	Acceptable Quality Levels (tightened inspection)											

Note: All values given in above table based on Poisson distribution as an approximation to the Binomial.

TABLE AND CHART C-F FOR SAMPLE SIZE CODE LETTER: F

CHART C-F - OPERATING CHARACTERISTIC CURVES FOR NORMAL-TIGHTENED SINGLE SAMPLING SCHEMES



Note: Figures on curves are Acceptable Quality Levels (AQL's) for normal-tightened inspection.

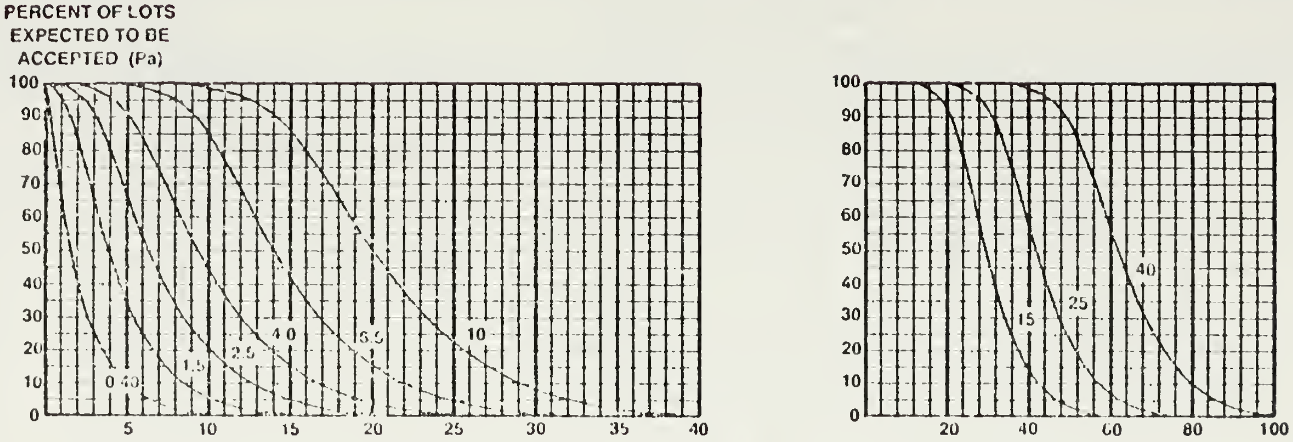
TABLE C-F-TABULATED VALUES FOR OPERATING CHARACTERISTIC CURVES FOR NORMAL-TIGHTENED SINGLE SAMPLING SCHEMES

Pa	ACCEPTABLE QUALITY LEVELS													
	.65	2.5	4.0	6.5	10	.65	2.5	4.0	6.5	10	15	25	40	65
	p(percent defective)					p(defects per hundred units)								
99.0	0.050	0.758	2.26	4.35	9.70	0.050	0.742	2.17	4.11	8.88	14.5	23.8	37.4	62.8
95.0	0.250	1.75	3.99	6.90	13.3	0.250	1.72	3.87	6.61	12.5	19.3	30.3	45.7	73.5
90.0	0.486	2.47	5.04	8.38	15.1	0.488	2.45	4.93	8.12	14.3	21.8	33.6	50.0	78.9
75.0	1.16	3.93	7.05	11.1	18.2	1.17	3.92	7.00	10.9	17.7	26.2	39.4	57.4	87.7
50.0	2.51	6.16	10.1	15.0	22.4	2.51	6.23	10.3	15.2	22.5	32.3	47.2	67.0	99.2
25.0	4.77	9.35	14.6	20.2	27.9	4.89	9.63	15.2	21.2	29.3	40.5	57.2	79.1	113
10.0	7.76	13.2	19.8	26.0	34.1	8.08	13.9	21.3	28.3	37.3	49.8	68.1	91.8	128
5.0	10.0	16.0	23.4	29.8	38.2	10.6	17.0	25.7	33.3	42.9	56.3	75.5	100	138
1.0	15.4	22.3	31.0	37.6	46.5	16.7	24.7	35.6	44.1	55.4	70.0	90.9	118	158

Note: Binomial distribution used for percent defective computation; Poisson for defects per hundred units.

TABLE AND CHART C-G FOR SAMPLE SIZE CODE LETTER: G

CHART C-G - OPERATING CHARACTERISTIC CURVES FOR NORMAL-TIGHTENED SINGLE SAMPLING SCHEMES



QUALITY OF SUBMITTED LOTS (p, in percent defective for AQL's ≤ 10; in defects per hundred units for AQL's > 10)

Note: Figures on curves are Acceptable Quality Levels (AQL's) for normal-tightened inspection.

TABLE C-G-TABULATED VALUES FOR OPERATING CHARACTERISTIC CURVES FOR NORMAL-TIGHTENED SINGLE SAMPLING SCHEMES

Pa	ACCEPTABLE QUALITY LEVELS														
	0.40	1.5	2.5	4.0	6.5	10	0.40	1.5	2.5	4.0	6.5	10	15	25	40
	p(percent defective)						p(defects per hundred units)								
99.0	0.031	0.470	1.39	2.66	5.95	9.71	0.031	0.463	1.36	2.57	5.55	9.06	14.9	23.3	39.3
95.0	0.156	1.09	2.47	4.24	8.08	12.7	0.156	1.08	2.42	4.13	7.78	12.1	18.9	28.6	46.0
90.0	0.306	1.55	3.12	5.17	9.23	14.2	0.306	1.54	3.08	5.07	8.97	13.6	21.0	31.3	49.3
75.0	0.733	2.48	4.39	6.89	11.1	16.7	0.736	2.47	4.37	6.84	11.1	15.4	24.6	35.9	54.8
50.0	1.60	3.92	6.37	9.41	14.0	20.1	1.61	3.95	6.42	9.50	14.1	20.2	29.5	41.9	62.0
25.0	3.05	6.00	9.26	12.9	17.8	24.5	3.11	6.11	9.50	13.3	18.3	25.3	35.7	49.4	70.9
10.0	5.00	8.52	12.7	16.8	22.0	29.2	5.13	8.79	13.3	17.7	23.3	31.2	42.6	57.4	80.2
5.0	6.49	10.4	15.2	19.4	25.0	32.3	6.71	10.8	16.1	20.8	26.8	35.2	47.2	62.6	86.4
1.0	10.0	14.6	20.4	25.0	31.0	38.5	10.6	15.6	22.3	27.6	34.6	43.8	56.8	73.5	99.0

Note: Binomial distribution used for percent defective computation; Poisson for defects per hundred units.

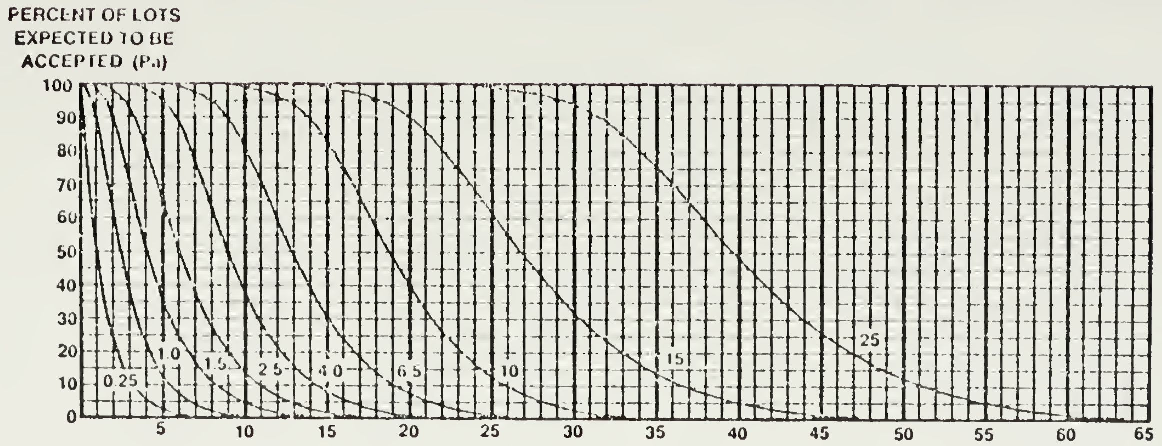
TABLE X-G-2 - SAMPLING PLANS FOR SAMPLE SIZE CODE LETTER: G

Type of sampling plan	Cumulative sample size	Acceptable Quality Levels (normal inspection)																																		Cumulative sample size
		Less than 0.40		0.40		0.65		X		1.0		1.5		2.5		4.0		6.5		10		X		15		X		25		X		40		Higher than 40		
		Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	
Single	32	▽		0	1	Use Letter F		Use Letter J		Use Letter H		1	2	2	3	3	4	5	6	7	8	8	9	10	11	12	13	14	15	18	19	21	22	△		32
Double	20	▽		•								0	2	0	3	1	4	2	5	3	7	3	7	5	9		10	7	11	9	14	11	16	△		20
	40											1	2	3	4	4	5	6	7	8	9	11	12	12	13	15	16	18	19	23	24	26	27			40
Multiple	8	▽		•								▪	2	▪	2	▪	3	▪	4	0	4	0	4	0	5	0	6	1	7	1	8	2	9	△		8
	16											▪	2	0	3	0	3	1	5	1	6	2	7	3	8	3	9	4	10	6	12	7	14			16
	24											0	2	0	3	1	4	2	6	3	8	4	9	6	10	7	12	8	13	11	17	13	19			24
	32											0	3	1	4	2	5	3	7	5	10	6	11	8	13	10	15	12	17	16	22	19	25			32
	40											1	3	2	4	3	6	5	8	7	11	9	12	11	15	14	17	17	20	22	25	25	29			40
	48											1	3	3	5	4	6	7	9	10	12	12	14	14	17	18	20	21	23	27	29	31	33			48
	56											2	3	4	5	6	7	9	10	13	14	14	15	18	19	21	22	25	26	32	33	37	38			56
		Less than 0.65		0.65		X		1.0		1.5		2.5		4.0		6.5		10		X		15		X		25		X		40		X		Higher than 40		
		Acceptable Quality Levels (tightened inspection)																																		

△ = Use next preceding sample size code letter for which acceptance and rejection numbers are available.
▽ = Use next subsequent sample size code letter for which acceptance and rejection numbers are available.
Ac = Acceptance number.
Re = Rejection number.
• = Use single sampling plan above (or alternatively use letter K).
▪ = Acceptance not permitted at this sample size.

TABLE AND CHART C-H FOR SAMPLE SIZE CODE LETTER: H

CHART C-H - OPERATING CHARACTERISTIC CURVES FOR NORMAL-TIGHTENED SINGLE SAMPLING SCHEMES



QUALITY OF SUBMITTED LOTS (p, In percent defective for AQL's < 10; In defects per hundred units for AQL's > 10)

Note: Figures on curves are Acceptable Quality Levels (AQL's) for normal-tightened inspection.

TABLE C-H-TABULATED VALUES FOR OPERATING CHARACTERISTIC CURVES FOR NORMAL-TIGHTENED SINGLE SAMPLING SCHEMES

Pa	ACCEPTABLE QUALITY LEVELS															
	0.25	1.0	1.5	2.5	4.0	6.5	10	0.25	1.0	1.5	2.5	4.0	6.5	10	15	25
	p(percent defective)							p(defects per hundred units)								
99.0	0.020	0.299	0 881	1.68	3.67	6.05	10.1	0.020	0.297	0.868	1.64	3 55	5.80	9.53	14.9	25.1
95 0	0 100	0.694	1.57	2.69	5.10	7.96	12.6	0.100	0 690	1.55	2.65	4.98	7.72	12.1	18.3	29.4
90 0	0 195	0.983	1.99	3.29	5.84	8 94	13.9	0.195	0.979	1.97	3.25	5.74	8.73	13.5	20.0	31.6
75.0	0.465	1.57	2 81	4.40	7.15	10.6	16.0	0.466	1.57	2.80	4.38	7.09	10.5	15 8	22.9	35.1
50 0	1.01	2.48	4.09	6 04	8.98	12.9	18.8	1.02	2.49	4.11	6.08	9.01	12.9	18.9	26.8	39.7
25.0	1.94	3.81	5.98	8.33	11.5	15.9	22.3	1.96	3 85	6.08	8.49	11.7	16.2	22.9	31.6	45.3
10.0	3.18	5.43	8.28	10.9	14.4	19.1	25.9	3.23	5.54	8.52	11.3	14.9	19.9	27.2	36.7	51.3
5.0	4.14	6.64	9.91	12.7	16.4	21.3	28.3	4.23	5.82	10.3	13.3	17.2	22.5	30.2	40.1	55.3
1.0	6.47	9.50	13.5	16.6	20.7	25.8	33.1	6.69	9.89	14.3	17.7	22.2	28.0	36.4	47.0	63.4

Note: Binomial distribution used for percent defective computation; Poisson for defects per hundred units.

10.4.1 Selecting the Sampling Plan. Two factors are generally considered in the selection of a sampling plan: (1) the consumer and/or supplier risk factor and (2) the economic factor. The risk pattern of each sampling plan is represented by the OC curve for the plan. The OC curve for each plan is different, a property which provides an effective means for ascertaining the effect of changes in sample size and acceptance number on the acceptance or rejection of a lot. The proper (with respect to risk) sampling plan can be determined from studying the OC curve for each plan under consideration. By studying the OC curves, it is possible to compare the relative risks of two or more sampling plans for a given sampling situation. By virtue of the OC curve, sampling tables can be constructed in which risks of incorrect decisions have been determined in advance, making it possible to select plans which will have risk factors that are acceptable to both the supplier and the consumer. The OC curve, then, can be used for classifying sampling plans from the standpoint of the protection afforded to the supplier (AQL plans), consumer (LQ plans), or both. The economic factor must be considered each time a sampling plan is to be selected and, of course, becomes more and more important as the cost of testing goes up. This factor becomes especially important when, because of the high cost of testing, sample size must be limited to a degree which forces a compromise of the risk requirements specified for the sampling plan. Another approach to selecting sampling plans is used by some organizations which handle many types of items. Instead of selecting a sampling plan on an item by item basis as the above procedure suggests, a standard operating procedure is established whereby a particular very stringent sampling plan (probably acceptance number of zero and large sample size, perhaps the entire population) is designated to use when inspecting any quality characteristic that may be a critical defect, a second but less stringent sampling plan is designated to use when inspecting any quality characteristic or group of quality characteristics that will be at worst a major defect(s), and a third and still less stringent sampling plan is designated to use when inspecting any quality characteristic or group of quality characteristics that will be no worse than a minor defect(s).

10.4.2 Effects of Changes to the Sampling Plan on the OC Curve. A sampling plan and its associated risks are completely defined by the lot size, sample size, and acceptance number. The lot size, except in the case of very small lots, has relatively little importance in most cases in determining the risks associated with any given sampling plan. Thus, sample sizes and acceptance numbers are the two important factors which influence the risk pattern of sampling plans. If the risks of a tentative sampling plan are considered unsatisfactory, the question which follows is: "What changes must be made to obtain the desired sampling protection?" This can be answered by considering the effect on the OC curve of changes in the sampling plan. To understand the effect of such changes, a more detailed study of the OC curve (see Figure 2) is appropriate. From examination of this curve it is seen that if lots to be inspected are 2% defective, approximately 90% of the lots are expected to be accepted, whereas if the lots submitted are 8% defective, about 10% of the lots are

expected to be accepted. If 2% defective and 8% defective represent good and bad quality lots, respectively, the good lots will be rejected 10% (100 - 90 = 10) of the time (producer's risk) and bad lots accepted but 10% of the time (consumer's risk). This rejection/acceptance frequency will occur by chance. If this frequency is intolerable, appropriate changes to the sampling plan are required.

10.4.3 Changes in Sample Size. An increase in sample size results in a steepening of the OC curve, as indicated in Figure 3. The steeper the OC curve, the greater the power of the sampling plan to discriminate between "good" and "bad" quality. Figure 3 clearly illustrates the effect that increasing sample size has on making the OC curve "steeper".

10.4.4 Changes in Acceptance Number. Figure 4 illustrates the effect of changes in the acceptance/rejection numbers on the OC curve. In general, the effect of increasing the acceptance number is to shift the location of the entire OC curve to the right. Changing the sampling plan in this way generally increases the probability of accepting a lot at a given quality level.

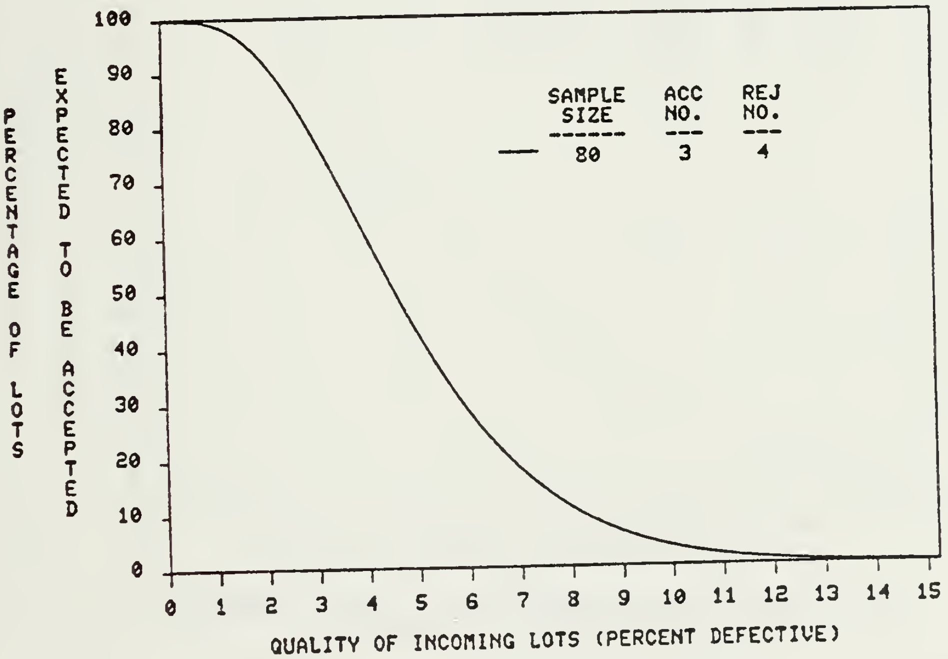


FIGURE 2. O.C. CURVE FOR A TYPICAL SAMPLING PLAN

10.4.5 Simultaneous Change of Sample Size and Acceptance Number. If it is desired to have more accurate disposition of the lots whose percent defective is close to the selected quality level (the AQL or the LQ for example), the sample size must be increased to provide more discrimination. Also, the acceptance number must be selected which will yield the OC curve that is properly located about the "desired" quality level. Thus, if the degree of discrimination of a given plan is considered adequate, but the probability of accepting a lot at a given quality level is too great (i.e., the plan is "too loose") or too small (i.e., the plan is "too tight"), proper adjustment is made by selecting the appropriate acceptance number. Usually in practice, if a sampling plan is desired which has certain desirable risk characteristics, both sample size and acceptance numbers must be simultaneously adjusted (See Figure 5). In order to make proper adjustment, however, the effect of each must be understood.

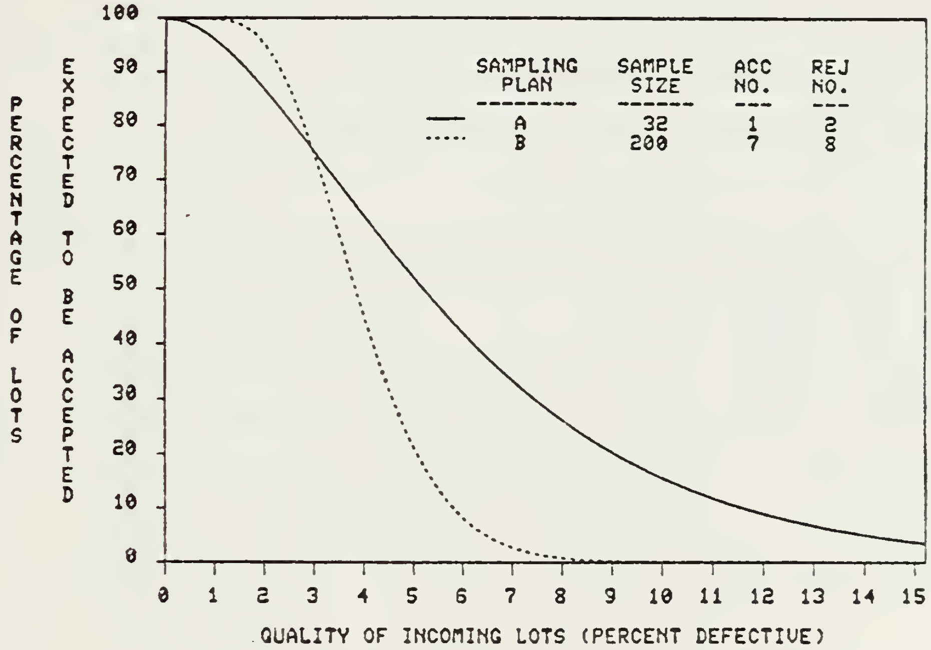


FIGURE 5. EFFECT OF SIMULTANEOUS CHANGE OF SAMPLE SIZE AND ACCEPTANCE NUMBER ON O.C. CURVE

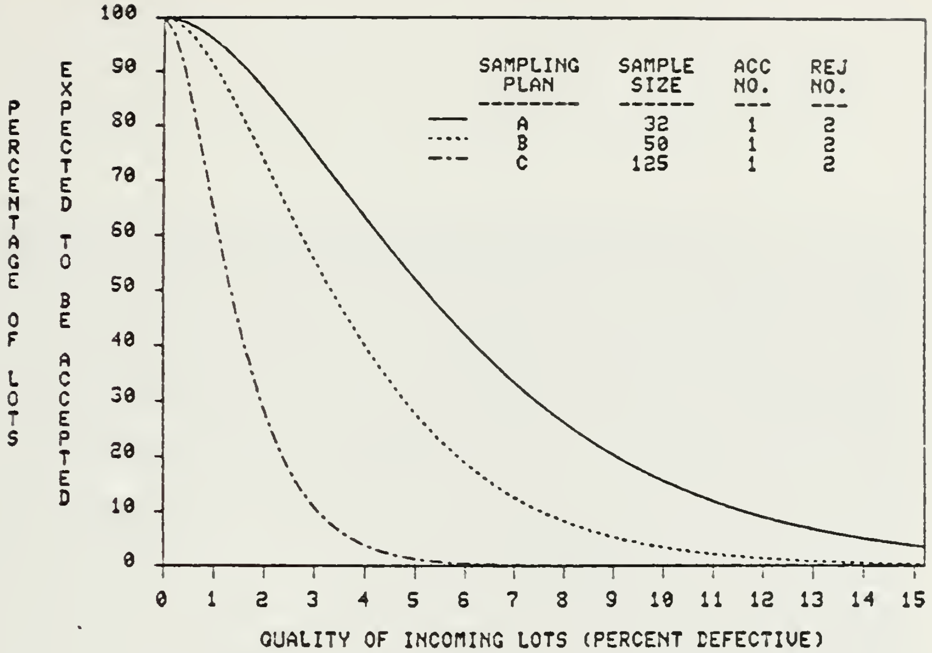


FIGURE 3. EFFECT OF CHANGING SAMPLE SIZE ON OC CURVE

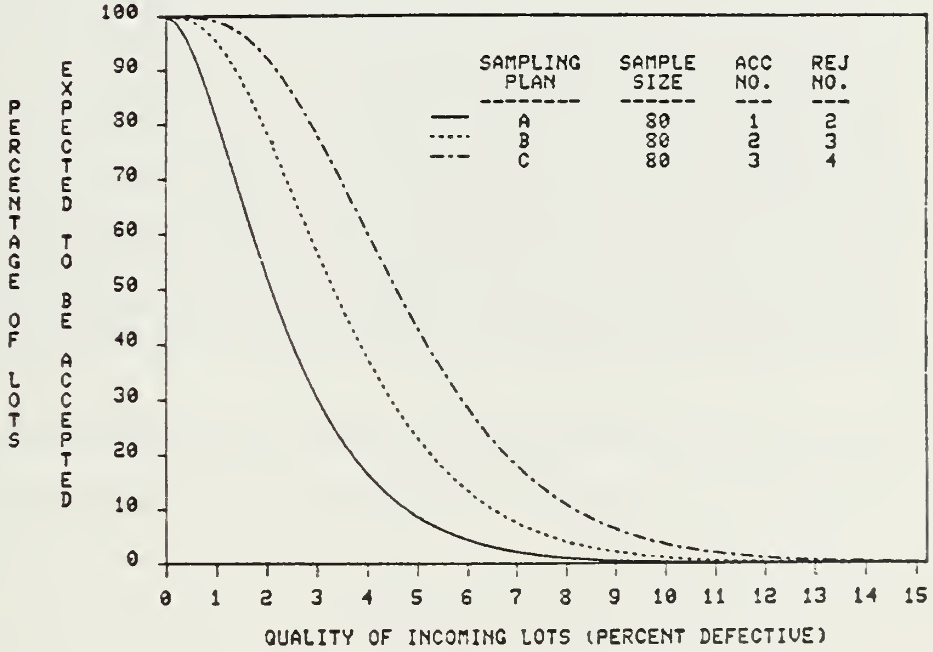


FIGURE 4. EFFECT OF CHANGING ACCEPTANCE NUMBER ON OC CURVE

TABLE A: TABLE OF RANDOM NUMBERS (Continued)

49	95012	68379	93526	70765	10592	04542	76463	54328	02349	17247	28865	14777	62730	92277
50	15664	10493	20492	38391	91132	21999	59516	81652	27195	48223	46751	22923	32261	85653
51	16408	61899	04153	53381	79401	21438	83035	92350	36693	31238	59649	91754	72772	02338
52	18629	61953	05520	91962	04739	13092	97662	24822	94730	06496	35090	04622	86774	98289
53	73115	35101	47498	87637	99016	71060	88824	71013	18735	20286	23153	72924	35165	43040
54	57491	16703	23167	49323	45021	33132	12544	41035	80780	45393	44812	12515	98931	91202
55	30405	83946	23792	14422	15059	45799	22716	19792	09983	74353	68668	30429	70735	25499
56	16631	35006	85900	98275	32388	52390	16815	69298	82732	38480	73817	32523	41961	44437
57	96773	20206	42559	78985	05300	22164	24369	54224	35083	19687	11052	91491	60383	19746
58	38935	64202	14349	82674	66523	44133	00697	35552	35970	19124	63318	29686	03387	59846
59	31624	76384	17403	53363	44167	64486	64758	75366	76554	31601	12614	33072	60332	92325
60	78919	19474	23632	27889	47914	02584	37680	20801	72152	39339	34806	08930	85001	87820
61	03931	33309	57047	74211	63445	17361	62825	39908	05607	91284	68833	25570	38818	46920
62	74426	33278	43972	10119	89917	15665	52872	73823	73144	88662	88970	74492	51805	99278
63	09066	00903	20795	95452	92648	45454	09552	88815	16553	51125	79375	97596	16296	66092
64	42238	12426	87025	14267	20979	04508	64535	31355	86064	29472	47689	05974	52468	16834
65	16153	08002	26504	41744	81959	65642	74240	56302	00033	67107	77510	70625	28725	34191
66	21457	40742	29820	96783	29400	21840	15035	34537	33310	06116	95240	1595,	16572	06004
67	21581	57802	02050	89728	17937	37621	47075	42080	97403	48626	68995	43805	33386	21597
68	55612	78095	83197	33732	05810	24813	86902	60397	16489	03264	88525	42786	05269	92532
69	44657	66999	99324	51281	84463	60563	79312	93454	68876	25471	93911	25650	12682	73572
70	91340	84979	46949	81973	37949	61023	43997	15263	80644	43942	89203	71795	99533	50501
71	91227	21199	31935	27022	84067	05462	35216	14486	29891	68607	41867	14951	91696	85065
72	50001	38140	66321	19924	72163	09538	12151	06878	91903	18749	34405	56087	82790	70925
73	65390	05224	72958	28609	81406	39147	25549	48542	42627	45233	57202	94617	23772	07896
74	27504	96131	83944	41575	10573	08619	64482	73923	36152	05184	94142	25299	84387	34925
75	37169	94851	39117	89632	00959	16487	65536	49071	39782	17095	02330	73401	00275	48280
76	11508	70225	51111	38351	19444	66499	71945	05422	13442	78675	84081	66938	93654	59894
77	37449	30362	06694	54690	04052	53115	62757	95148	78662	11163	81651	50245	34971	52924
78	46515	70331	85922	38329	57015	15765	97161	17869	45349	61796	66345	81073	49106	79860
79	30986	81223	42416	58353	21532	30502	32305	86482	05174	07901	54339	58861	74818	46942
80	63798	64995	46583	09785	44160	78128	83991	42865	92520	83531	80377	35909	81250	54238
81	82486	84846	99254	67632	43218	50076	21361	64816	51202	88124	41870	52689	51275	83556
82	21885	32906	92431	09060	64297	51674	64126	62570	26123	05155	59194	52799	28225	85762
83	60336	98782	07408	53458	13564	59089	26445	29789	85205	41001	12535	12133	14645	23541
84	43937	46891	24010	25560	86355	33941	25786	54990	71899	15475	95434	98227	21824	19585
85	97656	63175	89303	16275	07100	92063	21942	18611	47348	20203	18534	03862	78095	50136
86	03299	01221	05418	38982	55758	92237	26759	86367	21216	98442	08303	56613	91511	75928
87	79626	06486	03574	17668	07785	76020	79924	25651	83325	88428	85076	72811	22717	50585
88	85636	68335	47539	03129	65651	11977	02510	26113	99447	68645	34327	15152	55230	93448
89	18039	14367	61337	06177	12143	46609	32989	74014	64708	00533	35398	58408	13261	47908
90	08362	15656	60627	36478	65648	16764	53412	09013	07832	41574	17639	82363	60859	75567
91	79556	29068	04142	16268	15387	12856	66227	38158	22478	73373	88732	09443	82558	05250
92	92608	82674	27072	32534	17075	27698	98204	63863	11951	34648	88022	56148	34925	57031
93	23982	2,835	40055	67006	12293	02753	14827	23235	35071	99704	37543	11601	35503	85171
94	09915	96306	05908	97901	28395	14186	00821	80703	70426	75647	76310	88717	37890	40129
95	59037	33300	26695	62247	69927	76123	50842	43834	86654	70959	79725	93872	28117	19233
96	42488	78077	69882	61657	34136	79180	97526	43092	04098	73571	80799	76536	71255	64239
97	46764	86273	63003	93017	31204	36692	40202	35275	57306	55543	53203	18098	47625	88684
98	03237	45430	55417	63282	90816	17349	88298	90183	36600	78406	06216	95787	42579	90730
99	86591	81482	52667	61582	14972	90053	89534	76036	49199	43716	97548	04379	46370	28672
100	38534	01715	94964	87288	65680	43772	39560	12918	86537	62738	19636	51132	25739	56947

SECTION 20: SEQUENCE OF OPERATIONS IN USING MIL-STD-105

A typical sequence of operations in using the sampling procedures and tables for inspection by attributes of MIL-STD-105 is illustrated by Table C which follows. This table assumes a requirement for single sampling.

TABLE C: Sequence of Operational Steps

Steps	Explanation
1. Determine lot size.	1. Lot size controlled by lot formation criteria contained in procurement documents. Otherwise, establish by agreement between responsible authority and supplier.
2. Determine inspection level.	2. If the item specification does not give the inspection level, use inspection level II.
3. Determine sample size code letter.	3. Found in Table I, MIL-STD-105, based on lot size and inspection level.
4. Determine sampling plans.	4. Single sampling generally selected. Double or multiple sampling may be used.
5. Establish severity of inspection.	5. Normal inspection generally used at start of contract or production.
6. Determine sample size and acceptance number.	6. Assuming normal inspection and given the specified AQL value and the sample size code letter, the sample size and acceptance number are found in Table II-A, MIL-STD-105.
7. Select sample.	7. The sample, consisting of the number of units of product as determined from Table II-A, MIL-STD-105, is selected at random from the lot. Additionally, any obvious defectives that have not been selected for the inspection sample are removed from the lot (but are not included in the sample). (See para. 14.2)
8. Inspect sample.	8. The defectives (or defects) are counted. If this count does not exceed the acceptance number (Ac), the entire lot is accepted. If the count equals or exceeds the rejection number, the lot is rejected.
9. Record inspection results.	9. Compute estimated process average if required by operating procedures. Maintain record of accept/reject decisions in order that switching rules may be followed.

Steps	Explanation
10. Resubmit lot.	10. If the lot is not accepted, it may be resubmitted for acceptance inspection only after all units of the lot are reinspected and all defective units removed or reworked.

Example 6: Obtaining a Plan. Suppose the AQL is 1.0, the inspection level is II and the lot size is 2,500. The first thing required is the sample size code letter (usually called simply the code letter, for short). For a lot size of 2,500 and inspection level II, Table I gives the code letter as K. In the appropriate master table (Table II-A), it is found that the sample size for single sampling is 125. AQLs for normal inspection are given along the top of the table, and under the value 1.0 we find the numbers 3 and 4 given under the heading Ac Re (which stand for acceptance number and rejection number, respectively). The sampling plan required is:

Sample size	125
Acceptance number	3
Rejection number	4

Alternatively, Table X-K-2 could be used. Again the sample size of 125 is found; and in the column for AQL 1.0 are found the acceptance and rejection numbers 3 and 4 as before.

Example 7: Arrows in Tables II, III, and IV. Suppose the AQL is 0.40, the inspection level is I, and the lot size is 230. Table I gives the code letter as E. Using Table II-A, it is found that there is no plan for letter E and AQL 0.40 but a downward pointing arrow that directs us to letter G instead, and the required plan is:

Sample size	32
Acceptance number	0
Rejection number	1

Alternatively, the specifying of code letter E leads us, in the extended tables, to Table X-E-2. But this page has no column for AQL 0.40. Instead, the symbol of and inverted triangle appears for AQLs less than 1.0. This triangle refers to the footnote "Use next subsequent sample size code letter for which acceptance and rejection numbers are available." If the triangle is thought of as an arrowhead, it is pointing towards the edge of the page to be turned. This leads to letter F where again AQL 0.40 is not given, and on to letter G to find the same plan as before. It is very important to remember that if a triangle or series of triangles directs you from one page to another of the extended tables, or an arrow directs you from one row to another of the master tables, the sample size to be used is the one given for the new page or the new row arrived at and not the one given for the original page or row [9.4]. Where upward pointing arrows or triangles are found the meaning is similar. The triangles again point to the edge of the page to be turned.

APPENDIX C

EXCERPTS FROM OFPP PAMPHLET NO. 4

Two chapters from OFPP Pamplet No. 4, "A Guide for Writing and Administering Performance Statements of Work for Service Contracts", are provided in this appendix. These are Chapter 4, The Surveillance Plan, and Chapter 5, Doing Surveillance. Chapter 4 addresses quality assurance plan design and illustrates the role that MIL-STD-105D plays in the sampling process. Chapter 5 elaborates on the administrative procedures necessary in conducting inspection. It should be noted that the OFPP approach is equivalent to Air Force inspection procedures given in AFR 400-28. Finally, a Performance Requirement Summary (PRS) form is shown.

CHAPTER 4

THE SURVEILLANCE PLAN

4-1. Basic Approach. This chapter describes the major contents of a surveillance plan. There are three key ideas that are the basis for a surveillance plan.

a. Management By Exception. Quality assurance relates to the output service provided by the contractor. As pointed out earlier, the output service can result either from a contractor-developed procedure or from an government specified procedure. When the procedure is specified by the government, compliance with the procedure is the desired output service.

(1) When the output is based on a contractor developed procedure, the procedures are only looked at on a by-exception basis; that is, satisfactory performance of the output service as specified in the contract normally indicates that the contractor is using satisfactory procedures. The government should be concerned only when services are not adequately performed.

(2) In this case, the inspector looks beyond the level of services provided only to determine if the problem is caused by the government or the contractor. If government provided items to the contractor's operation (such as, parts, equipment, or facilities) are at fault, action must be taken through government channels to correct the problem. No action will be required of the contractor. When the problem is the contractor's fault, the contractor is told to take corrective action.

b. Performance Indicator. The level of contractor provided services is monitored by checking the performance values in the statement of work (SOW). As described in chapter 2, a performance value is a feature of the service that can be measured by a number. For example, two important performance values in vehicle maintenance and vehicle operations are vehicle out-of-commission (VOC) rate and taxi response time.

c. Problem Location. When performance values show that the service is not adequately performed, the QAE uses decision tables to locate the problem. The tables provide a logical sequence to find the problem cause. Basically, they are a set of pointers which should find the problem's source in a step-by-step fashion. The construction and use of decision tables are described in paragraph 4-4b.

VEHICLE OPERATIONS

Required Service	Standard	Maximum Allowable Degree of Deviation from Requirement (AQL).	Method of Surveillance	Deduction from Contract Price for Exceeding the AQL.
Operate Taxi	Customer must be picked up within 4 minutes of the agreed upon time.	5 %		19.2 %
Operate Bus	Bus must not arrive at the stop later than scheduled time or depart earlier than schedule time +5 min.	4%		15.4 %
Operate Unscheduled Bus	Bus must arrive not later than 4 minutes from agreed upon time between customer and dispatcher.	5%		3.8 %

Figure 3-1. Performance Requirements Summary.

4-2. Surveillance Information Sources. There are four principal sources of information for surveillance: management information systems, random sampling, checklists, and formal customer complaints. The following sections describe the information sources in detail.

a. Management Information Systems. In a few instances, an existing management information system (MIS) may be available as a means of surveillance. When a MIS is available, as in the case of the Air Force's vehicle integrated management system (VIMS) in the vehicle maintenance area, it can collect information on performance values which can be used instead of random sampling data.

(1) Management information systems usually collect information for 100 percent of the activities for a specified period of time. This information can be compared to a contract standard. On the basis of this comparison, performance can be judged and the performance for the specified period accepted or rejected.

(2) For example, the vehicle out-of-commission (VOC) rate is computed every month by the VIMS. A simple comparison of the VOC rate with the maximum acceptable VOC in the SOW explains a great deal about the level of maintenance service supporting the base vehicles and organizations.

(3) By way of caution, however, one must check the data input into a MIS if the system is maintained by the contractor. If one is going to use a MIS to check the contractor, make sure the MIS contains reliable data.

b. Random Sampling. The most frequently used way of service contract surveillance is random sampling. Services are sampled by the QAE to determine if the contractor's level of performance is acceptable. Acceptance sampling is done, basically, to determine a course of action: that is, whether to accept or reject the contractor's level of performance during a given period of time. If it rejects performance, certain actions are started. If it accepts performance, no action is taken.

(1) The basis for doing random sampling is MIL-STD-105D, Sampling Procedures and Tables for Inspection by Attributes which is widely understood and used by both the government and contractors. It is based on the concept of an attribute. An attribute is a feature of a service which either does, or does not, match a standard (for example, a taxi is on time or it is not on time).

(2) When sampling by attributes, a certain number of observations will match the standards and the remaining number will not match. Therefore, attribute sampling is useful for describing how a job is done, in terms of defects per hundred observations, or percent defective. Using this concept, sampling for a performance indicator can be developed by proceeding through a number of formal steps based on MIL-STD-105D. The use of these concepts is described in paragraph 4-3, Sampling Plan.

c. Surveillance Checklists. Checklists are also used to check contract performance. They must be used sparingly, however. The use of the MIS and random sampling are preferred information sources. Checklists help in surveillance of contract requirements that happen infrequently. (For example, if a contractor is required to perform a service once a month, this service would be included on a checklist.) Any service that is not provided on a daily basis should be considered for inclusion on a checklist unless a MIS can be used to determine the quality of the service.

d. Formal Customer Complaints. Even the best surveillance plan will not allow the QAE to check all aspects of the contractor's performance.

(1) Formal customer complaints are a means of documenting certain kinds of service problems. The way to get and document customer complaints needs to be carefully planned by the persons checking the service contract.

(2) Customer complaints are not truly random. They are seldom used to reject a service or deduct money from the contractor.

(3) When random sampling is the chosen method of surveilance, a customer complaint cannot be used to satisfy a random observation. However, it can be used as further evidence of unsatisfactory performance if random sampling shows that the specific service is unsatisfactory. These complaints can be used to decide if action other than a deduction should be taken.

(a) Getting Customer Complaints. An aggressive customer complaint program, once established, needs to be briefed to every organization that receives the contractor's services. An operating instruction should be given to each organization outlining the customer complaint program, the format and the content of a formal customer complaint, and the action which can be expected from those assigned to watching and managing the service contract.

(b) Documenting the Customer Complaint. Normally, each customer complaint is brought, either in person or by telephone, to the person checking contract performance. Enter information about the complaint into a Customer Complaint Record, similar to the sample shown in figure 4-1. The record contains the following information:

1 Date and time of complaint.

2 Source of complaint - organization and individual.

3 Nature of complaint (narrative description).

4 Contract reference of complaint related services.

5 Valid complaint (Yes or No).

6 Date contractor informed of complaint.

7 Action taken by contractor.

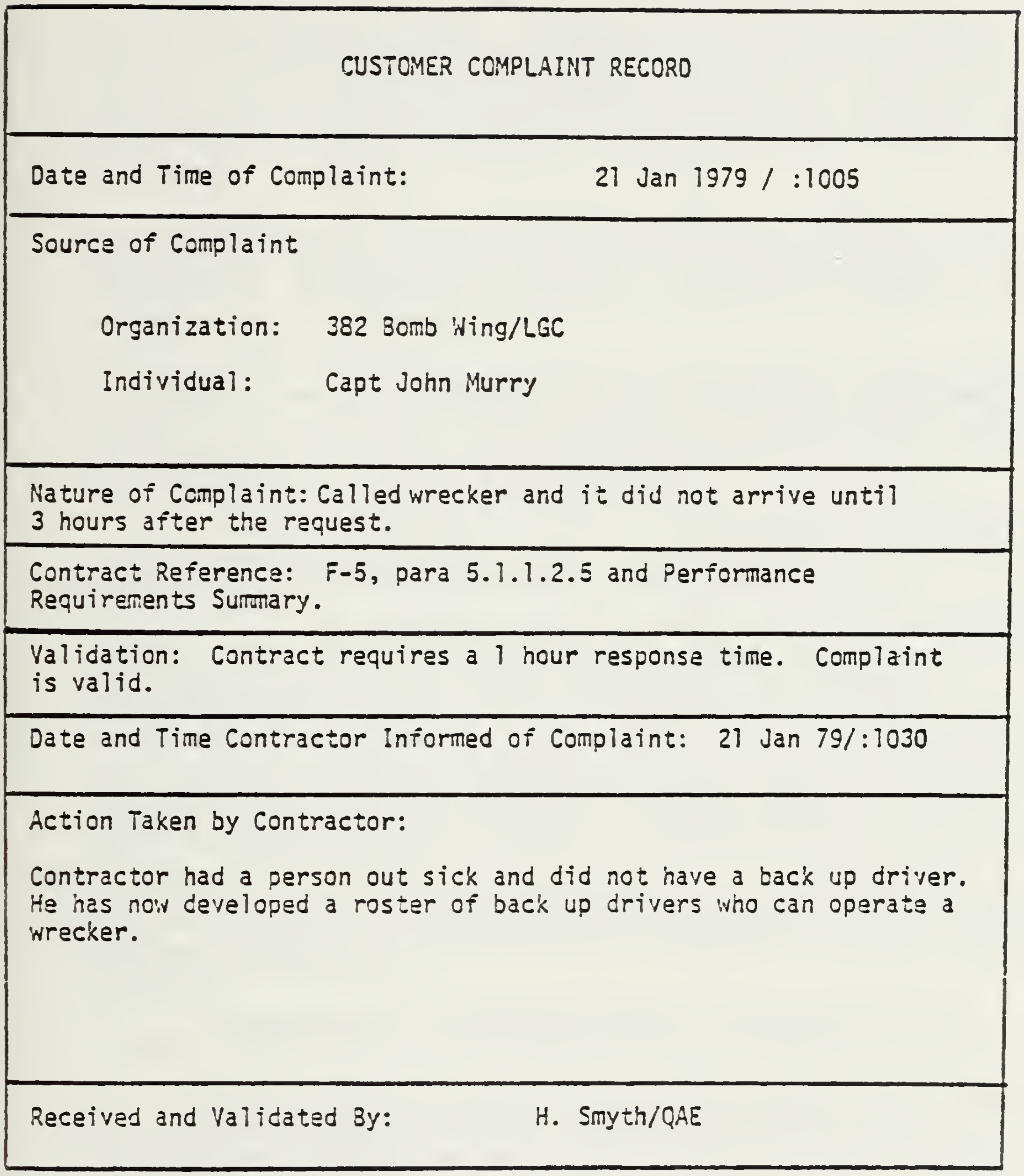
8 Signature of the person receiving and validating the complaint.

4-3. Sampling Plan. As a rule, a plan contains information on the acceptable quality level, lot size, sample size, and rejection level. It states the number of units from each lot to be inspected (that is, the sample size). It also states the criteria for determining the acceptability of the lot (acceptance and rejection numbers). This information is used to build the sampling guide which are the major products in a surveillance plan for a service contract.

a. Beginning the Plan. To begin building a sampling plan, go to the Performance Requirements Summary developed during the "Write Statement of Work" step, chapter 3, figure 3-1.

(1) This chart contains the required services, the standards, and acceptable quality levels. At this time decide how the services will be checked (what information source or method of surveillance will be used).

(2) Show these decisions on the chart. For each service where random sampling is used, complete the steps described below.



CUSTOMER COMPLAINT RECORD

Date and Time of Complaint: 21 Jan 1979 / :1005

Source of Complaint

Organization: 382 Bomb Wing/LGC

Individual: Capt John Murry

Nature of Complaint: Called wrecker and it did not arrive until 3 hours after the request.

Contract Reference: F-5, para 5.1.1.2.5 and Performance Requirements Summary.

Validation: Contract requires a 1 hour response time. Complaint is valid.

Date and Time Contractor Informed of Complaint: 21 Jan 79/:1030

Action Taken by Contractor:

Contractor had a person out sick and did not have a back up driver. He has now developed a roster of back up drivers who can operate a wrecker.

Received and Validated By: H. Smyth/QAE

Figure 4-1. Customer Complaint Record.

b. Deciding on the Acceptable Quality Level (AQL). The AQL is the highest number of defects per hundred, highest percent defective or highest number of defects that can be allowed for any service performance indicator. There are only a limited number of AQLs listed in MIL-STD-105D but, in virtually all cases, one will be close enough to control the contractor's level of service.

(1) The first step in designing a sampling plan under MIL-STD-105D is the selection of a realistic AQL. No service can be perfectly performed. The AQLs placed on the Performance Requirements Summary in figure 3-1, must be adjusted at this time.

(2) Find the closest AQL from figure 4-2 and use it to replace the original AQL on the Performance Requirement Summary. For example, the AQL for taxi service might have been 5 percent. This would be changed to 4 percent or 6.5 percent since 5 percent does not appear in the figure.

c. Determining the Lot Size. To determine the sample size, the lot size must be known. The lot is how often the contractor provides the service in a period of time.

(1) To determine the lot size, estimate (or count) the frequency of the service to be sampled, during the period it is to be sampled. Thus, if scheduled bus service timeliness is the service being sampled, and a sample is taken each month, the lot size is the number of times that are available during the month to observe bus timeliness. In this case, it would be the number of times the buses go around all the routes each day, multiplied by the number of days in each month on which the bus routes operate.

(2) In the case of workorders, the monthly lot size can be estimated from historical information on file. The projected workload data gathered in chapter 2 is used to help determine lot sizes.

d. Determining the Sample Size. Use figure 4-3 to identify an appropriate sample size for a given lot size.

(1) Use the normal sample size column unless there is a limited number of QAEs or unless the cost of an inspection suggests the use of the medium or small sample size column.

(2) Use the medium or small sample size, if inspections for a particular service are lengthy or hinder the contractor's ability to provide service to customers.

Allowable Acceptable Quality Levels
0.010 %
0.015 %
0.025 %
0.040 %
0.065 %
0.10 %
0.15 %
0.25 %
0.40 %
0.65 %
1.0 %
1.5 %
2.5 %
4.0 %
6.5 %
10. %
15. %
25. %
40. %
65. %

Figure 4-2. List of MIL-STD-105D Acceptable Quality Levels.

Lot Size	Normal Sample Size	Medium Sample Size	Small Sample Size
2-8	2	2	2
9-15	3	2	2
16-25	5	3	3
26-50	8	5	5
51-90	13	5	5
91-150	20	8	8
151-280	32	13	13
281-500	50	20	13
501-1,200	80	32	20
1,201-3,200	125	50	32
3,201-10,000	200	80	32
10,001-35,000	315	125	50
35,001-150,000	500	200	80
150,001-500,000	800	315	80
500,000 and over	1250	500	125

Figure 4-3. Sample Size.

e. Selecting the Rejection Level. Use MIL-STD-105D to identify the acceptance and rejection level for the sample size (see figure 4-4). To use the figure, begin with the known values for the AQL and the sample size.

(1) Find the selected sample size (in the sample size column) and read across that line to the column for the selected AQL. At that point there will either be two numbers or an arrow pointing up or down.

(2) If there is an arrow, follow the direction of the arrow until it leads to a pair of numbers. Of the two numbers at the intersection or at the end of the arrow, the number on the left (Ac or accept) indicates the maximum number of defects which can occur in a sample and still permit the total group or lot to be judged acceptable.

(3) When there is no accept of reject number for a given sample size and AQL, following the arrow will also cause a change in sample size. For example, with an AQL of 1.5 and a sample size of 20, the sample size would become 32.

(4) The number on the right (Re or reject) indicates the minimum number of defects that occur in a sample which causes the total group or lot to be judged unacceptable. For example, suppose the sample size is determined to be 32 and the AQL has been set at 6.5 defects per hundred. Find the number 32 in the sample size column and read across that line until the AQL column for 6.5 has been reached. The two numbers at that intersection are 5 and 6.

(a) In other words, the number on the left, 5, is the number of defects which can be found in a sample and still permit acceptance of the lot.

(b) The number 6, to the right of 5, is the smallest number of defects needed to declare the lot unacceptable and subject to further check, using the decision tables.

4-4. Developing the Sampling Method. The final thing to be decided in sampling is how the sample will be drawn. The objective in the method is to insure that the sample is random (that is, that all services have an equal chance of being selected). To achieve random selection, use a random number table, as explained in the following examples (see attachment 1 for the whole table). Most items will fall into one of these examples.

Single sampling plans for normal inspection

Sample size code letter	Sample size	Acceptable Quality Levels (normal inspection)																									
		0.010	0.015	0.025	0.040	0.065	0.10	0.15	0.25	0.40	0.65	1.0	1.5	2.5	4.0	6.5	10	15	25	40	65	100	150	250	400	650	1000
		Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re
A	2	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	0 1	⇩	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31
B	3	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	0 1	⇧	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45
C	5	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	0 1	⇧	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	⇧
D	8	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	0 1	⇧	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	⇧	⇧
E	13	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	0 1	⇧	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	⇧	⇧	⇧
F	20	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	0 1	⇧	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	⇧	⇧	⇧	⇧	⇧	⇧
G	32	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	0 1	⇧	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	⇧	⇧	⇧	⇧	⇧	⇧	⇧
H	50	⇩	⇩	⇩	⇩	⇩	⇩	⇩	0 1	⇧	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧
J	80	⇩	⇩	⇩	⇩	⇩	⇩	0 1	⇧	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧
K	125	⇩	⇩	⇩	⇩	⇩	0 1	⇧	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧
L	200	⇩	⇩	⇩	⇩	0 1	⇧	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧
M	315	⇩	⇩	⇩	0 1	⇧	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧
N	500	⇩	⇩	0 1	⇧	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧
P	800	⇩	0 1	⇧	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧
Q	1250	0 1	⇧	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧
R	2000	⇧	⇧	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧

⇩ = Use first sampling plan below arrow. If sample size equals, or exceeds, lot or batch size, do 100 percent inspection.
⇧ = Use first sampling plan above arrow.
Ac = Acceptance number.
Re = Rejection number.

Figure 4-4. MIL-STD-105D Acceptance, Rejection Levels for Normal Inspection.

(3) Go to the next number, 60756. The last part of this number, 756, falls within the brackets one is looking for, so workorder 756 is selected to be sampled. The next random number group is 92144. Since 144 is not within the brackets, move to the next group 49442. Again, 442 is not within the brackets and therefore is not selected to be sampled.

(4) This process would be continued until three workorders are selected.

c. How To Use The Random Number Table To Identify Random Sample From a List. If a number of items need to be sampled that are not consecutively numbered, the simplest solution is to list the identifiers, for all the items in the lot, in a column, on a piece of lined paper.

(1) Next, number the lines consecutively, beginning with the number one hundred. Now use the random number table to draw the sample from the line numbers. A selected line number leads to the identifier located on that line and that identifier tells which item to sample. For example, if one chooses to sample a set of workorders with attached sales slips, one is not going to have to have a set of consecutively numbered workorders because not every workorder has a sales slip attached.

(2) List the workorders with sales slips in a column, number each line in the column, and randomly select enough line numbers to make up the sample.

d. How To Use The Random Number Table To Identify a Random Sample of Days. Suppose one wants to identify 4 days in the month on which to sample something. The days of the month can be numbered 01 to 31 (or less, as appropriate). Begin in the random number table in figure 4-5 at 77452.

(1) It is best to use a starting point different from the one used in the previous example but for the purpose of this example it is being used again.

(2) One can move down the column from random number group to random number until the first number between 01 and 31 is spotted. In this case, it is 23216 or, using the rule to discard the numbers to the left of the number of digits, simply 16. Thus the 16th day of the month is selected for sampling.

(3) Continuing in this fashion, one discovers that 58731, or simply 31, or the 31st, is the next day for sampling. Proceed in this manner until the four days for sampling have been identified.

(4) If it is not desirable to sample on weekends, discard those days selected that happen to fall on a weekend and continue that selection until the proper number of days has been selected.

e. How To Use the Random Number Table To Identify a Random Sample of Times of Day. If one wants to select random times of day to sample a service such as taxi or bus service, use the 24 hour clock.

(1) If there are any constraints during each 24-hour period, take them into consideration. For example, suppose that base bus service operates between 0700 and 2345. In this case, go through the number table until one finds a group of four numbers that correspond to an acceptable time between 0700 and 2345. Again, using figure 4-5, and proceeding across the line from the initial number, one comes to 60756 or 0756 hrs as the first random time.

(2) The next random number is 92144 or 2144 hrs. The number is good and so one schedules an observation for 2144 hrs.

(3) Proceed in this manner until the desired number of sample times have been identified.

f. How To Insure Variety in the Use of the Random Number Table. The use of variety in the random number table ensures that detectable patterns do not occur.

(1) Besides starting at different random points and alternating the patterns for finding a string of random numbers, the user may, at some point in time, wish to use the first significant digits instead of the last.

(2) For instance, in the random number group 77452 one has customarily used the last three digits (that is, 452) when looking for a random number with three digits. But there is no reason why one could not for a period of time use the first three digits, or 774.

(3) Success in using the tables requires consistency but also variety. The above information should ensure that the tables are properly used and that the sample is randomly drawn.

4-5. Surveillance Plan Products. Several written documents are included in a surveillance plan:

a. Sampling Guides. A sampling guide is used for surveillance. It is used in a surveillance plan to present

a. Use Of The Random Number Table. The random numbers in figure 4-5 are arranged in groups of five numbers (51259, 77452, and so on).

(1) To use the table, begin by picking at random a group of numbers on any page of the table. This is usually done by closing the eyes and pointing with a pencil or finger to some initial group.

(2) To identify additional random numbers, follow a pattern. Go along a given line to its end and then along the next line to its end and so on through the table until enough numbers have been selected or until the table ends.

(3) If the table ends and there are still more numbers to select, go back to the beginning of the table and continue using the same pattern. Use various patterns alternately; for example, use lines for one sample, use columns for the next sample, and use a diagonal pattern for the third sample.

b. How To Use the Random Number Table To Identify a Random Sample of Consecutively Numbered Workorders. Suppose one has to identify a random sample of 3 workorders for inspection. This can be done at the beginning of the month (before the workorders are written) or at the end of the month (to select workorders already on file).

(1) If there are, or might be, 200 workorders to select from, then one begins by listing the lowest workorder number (known or projected). This could be #001 or possibly #743, for example.

(a) List the highest workorder number (known or projected); in this case, it could be #200 or #943. With these boundaries now enter the random number table to the first group of numbers. For this example, use workorders numbered #743 to #943.

(b) If the last three digits in the first group of random numbers is not between 743 and 943, discard that group of numbers and go to the next group.

(2) Again, using figure 4-5, if one starts at the initial 77452, disregard the two numbers to the left of the three significant digits, or in this case, 77. The remaining number is 452. Since this is not between 743 and 943, go to the next group in the same line which is 16308, again, discard the leftmost two numbers, and the number is 308. This is again too low.

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Line / Col.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1	10480	15011	01536	02011	81647	91646	69179	14194	62590	36207	20969	99570	91291	90700
2	22368	46573	25595	85393	30995	89198	27982	53402	93965	34095	52666	19174	39615	99505
3	24130	48360	22527	97265	76393	64809	15179	24830	49340	32081	30680	19655	63348	58629
4	42167	93093	06243	61680	07856	16376	39440	53537	71341	57004	00849	74917	97758	16379
5	37570	39975	81837	16656	06121	91782	60468	81305	49684	60672	14110	06927	01263	54613
6	77921	06907	11008	42751	27756	53498	18602	70659	90655	15053	21916	81825	44394	42880
7	99562	72905	56420	69994	98872	31016	71194	18738	44013	48840	63213	21069	10634	12952
8	96301	91977	05463	07972	18876	20922	94595	56869	69014	60045	18425	84903	42508	32307
9	89579	14342	63661	10281	17453	18103	57740	84378	25331	12566	58678	44947	05585	56941
10	85475	36857	53342	53988	53060	59533	38867	62300	08158	17983	16439	11458	18593	64952
11	28918	69578	88231	33276	70997	79936	56865	05859	90106	31595	01547	85590	91610	78188
12	63553	40961	48235	03427	49626	69445	18663	72695	52180	20847	12234	90511	33703	90322
13	09429	93969	52636	92737	88974	33488	36320	17617	30015	08272	84115	27156	30613	74952
14	10365	61129	87529	85689	48237	52267	67689	93394	01511	26358	85104	20285	29975	89868
15	07119	97336	71048	08178	77233	13916	47564	81056	97735	85977	29372	74461	28551	90707
16	51085	12765	51821	51259	77452	16308	60756	92144	49442	53900	70960	63990	75601	40719
17	02368	21382	52404	60268	89368	19885	55322	44819	01188	65255	64835	44919	05944	55157
18	01011	54092	33362	94904	31273	04146	18594	29852	71585	85030	51132	01915	92747	64951
19	52162	53916	46369	58586	23216	14513	83149	98736	23495	64350	94738	17752	35156	35749
20	07056	97628	33787	09998	42698	06691	76988	13602	51851	46104	88916	19509	25625	58104
21	48663	91245	85828	14346	09172	30168	90229	04734	59193	22178	30421	61666	99904	32812
22	54164	58492	22421	74103	47070	25306	76468	26384	58151	06646	21524	15227	96909	44592
23	32639	32363	05597	24200	13363	38005	94342	28728	35806	06912	17012	64161	18296	22851
24	29334	27001	87637	87308	58731	00256	45834	15398	46557	41135	10367	07684	36188	18510
25	02488	33062	28834	07351	19731	92420	60952	61280	50001	67658	32586	86679	50720	94953
26	81525	72295	04839	96423	24878	82651	66566	14778	76797	14780	13300	87074	79666	95725
27	29676	20591	68086	26432	46901	20849	89768	81536	86645	12659	92259	57102	80428	25280
28	00742	57392	39064	66432	84673	40027	32832	61162	98947	96067	64760	64584	96096	98253
29	05366	04213	25669	26422	44407	44048	37937	63904	45766	66134	75470	66520	34693	90449
30	91921	26418	64117	94305	26766	25940	39972	22209	71500	64568	91402	42416	07844	69618
31	00582	04711	87917	77341	42206	35126	74087	99547	81817	42607	43808	76655	62028	76630
32	00725	69884	62797	56170	86324	88072	76222	36086	84637	93161	76038	65855	77919	88006
33	69011	65795	95876	55293	18988	27354	26575	08625	40801	59920	29841	80150	12777	48501
34	25976	57948	29888	88604	67917	48708	18912	82271	65424	69774	33611	54262	85963	03547
35	09763	83473	73577	12908	30883	18317	28290	35797	05998	41688	34952	37888	38917	88050
36	91567	42595	27958	30134	04024	86385	29880	99730	55536	84855	29080	09250	79656	73211
37	17955	56349	90999	49127	20044	59931	06115	20542	18059	02008	73708	83517	36103	42791
38	46503	18584	18845	49618	02304	51038	20655	58727	28168	15475	56942	53389	20562	87338
39	92157	89634	94824	78171	84610	82834	09922	25417	44137	48413	25555	21246	35509	20468
40	14577	62765	35605	81263	39667	47358	56873	56307	61607	49518	89656	20103	77490	18062
41	98427	07523	33362	64270	01638	92477	66969	98420	04880	45585	46565	04102	46880	45709
42	34914	63976	88720	82765	34476	17032	87589	40836	32427	70002	70663	88863	77775	69348
43	70060	28277	39475	46473	23219	53416	94970	25832	69975	94884	19661	72828	00102	66794
44	53976	54914	06990	67245	68350	82948	11398	42878	80287	88267	47363	46634	06541	97809
45	76072	29515	40980	07391	58745	25774	22987	80059	39911	96189	41161	14228	60697	59583
46	90725	52210	83974	29992	65831	38857	50490	83765	55657	14361	31720	57375	56228	41546
47	64364	67412	33339	31926	14883	24413	59744	92351	97473	89286	35931	04110	23726	51900
48	08962	00358	31662	25388	61642	34072	81249	35648	56891	69352	48373	45578	78547	81788
49	95012	68379	93526	70765	10592	04542	76463	54328	02349	17247	28865	14777	62730	92277
50	15664	10493	20492	38391	91132	21999	59516	81652	27195	48223	46751	22923	32261	85653

Figure 4-5. How To Use A Random Number Table.

the information needed to sample the performance of a particular service. Information for the sampling guide is developed while the sampling information is being derived for the sampling plan. The steps involved in developing sampling information are described in paragraph 4-3. As shown in figure 4-6, a sampling guide has these sections:

(1) A statement of the AQL and its meaning in layman's terms.

(2) The lot size for sampling.

(3) The sample size.

(4) A description of the sampling procedure which tells how the service will be sampled.

(5) An explanation of the inspection procedure which tells what will be checked during the inspection of the sample.

(6) Acceptable performance criteria which states the acceptance and rejection levels.

b. QAE Decision Tables. Once a problem has been discovered, the inspector must turn to a decision table and use the information in that table to aid him in finding the source of the problem. The decision table lists the symptoms of the problem and identifies the possible sources of the problem. Questions are established for each potential source to determine the contributing factors. A decision logic entry is worked up for each required service. As soon as it is considered satisfactory, the information is transferred to the decision table. An example of a decision logic entry is shown as part of a decision table in the sample in figure 4-7.

c. Checklists. There are two main uses for checklists.

(1) Tally Checklists. Tally checklists are used to document all sample observations made during a sampling period. Checklists may be preprinted with any format which contains the following information:

(a) Contract requirements - a statement of the service being inspected.

(b) Date, time, entry for each observation.

(c) Observation identifier of applicable workorder number, bus stop, or sales slip number, meal period, etc.

VO Sampling Guide #3
Vehicle Condition Monitoring

1. Acceptable Quality Level (AQL): 10%
In the long run there must be no more than 10 defects per hundred vehicles.

2. Lot Size: ____ vehicles operated by the contractor.

3. Sample Size: ____vehicles operated by the contractor.

4. Sampling Procedure:
At the beginning of the month, list the registration numbers of all contractor operated vehicles on a sheet of ruled paper. Beginning with the number 100, number the lines on the paper to correspond with the vehicle registration numbers. Using the random number table select line numbers equal to the sample size. The vehicle registration numbers on these lines indicate the vehicles to be sampled during the month. Schedule the inspections evenly over the month.

5. Inspection Procedure:
Inspect the vehicles using vehicle/equipment discrepancy and maintenance report as a guide (see AFM 77-310, Vol II, Chap 6). Record defects per vehicle for each of the inspected vehicles. Any defects found not already noted by the contractor shall cause the observation to be recorded as unsatisfactory.

6. Performance Criteria:

a. Performance is acceptable when ____ or less defective vehicles are discovered per month.

b. Performance is unacceptable when ____ or more defective vehicles are discovered during a month..

7. Phase-In Period: During the first two months of the contract the following AQL's (paragraph 1) and performance criteria (paragraph 6) apply:

a. AQL: 15%

b. Performance is acceptable if ____ or fewer defects are discovered per month.

c. Performance is unacceptable if ____ or more defects are discovered per month.

Figure 4-6. Sampling Guide.

IF THE CONTRACTOR'S DEFICIENCY IS:	PROBABLE CAUSE FACTORS/ IMPACTING CONDITIONS ARE:	WHICH COULD RESULT FROM:	SUGGESTED REVIEW PROCEDURES AND/OR PREVENTIVE MEASURES IS/ARE:
Vehicle out of commission hours too high	High vehicle down for maintenance hours (VDM)	Poor control over work documentation	Review PCNs N310032, N310030, or N310031 for individual vehicles reflecting VDM hours in excess of the reporting period available hours. If this condition exists, it is usually found that two or more work orders were in "open" status for the same vehicle at the same time. Normally results from failure to ensure "close" of a particular work order, and not reviewing the PCN N310018, Work Order Master File Status Report previous to initiating a new work order. (Frequently noted when two or more work orders were required to satisfy contract maintenance work requirements). Are changes from VDM to VDP status accomplished in a timely manner?
		Insufficient manning	Review PCN N310032 for individual vehicle data reflecting a very low ratio of direct labor compared to VDM hours accrued. One prime indicator of this problem prevailing is when "Estimated Times in Commission" (ETIC), is constantly slipped. (When work is hardly ever completed within time-frame allotted by labor hour estimates).
		Improper control over work flow	Determine the appropriateness of workflow prioritizing and the disruptive effect caused by over-reacting to unrealistic application of priorities, such as shifting technicians from one vehicle to another, shuffling vehicles from one location to another for shop spaces, etc.

Figure 4-7. QAE Decision Table.

(d) Result of observation - either satisfactory or defective.

(e) Any pertinent comment for an observation. An example of a checklist for sampling is shown in figure 4-8.

(2) Surveillance Activity Checklists. When a specific service or procedure occurs rarely or is not important enough to survey on a continuing basis, use a Surveillance Activity Checklist. This type of checklist must be prepared and included in the surveillance plan. An example of this kind of checklist is shown in figure 4-9.

4-6. Contract Administrator's Plan. The contract administrator has an obligation to see how well the QAE is doing the job. The contract administrator must also make some independent checks of contractor performance, preferably by using the same techniques that go into the design of the QA surveillance plan. (This plan is completed at the same time as the surveillance plan.) As a minimum this plan must call for a quarterly review of the QAE's use of sampling guides and an annual review of surveillance activity checklist items.

Vehicle Operations Sampling Guide #3

Vehicle Condition Monitoring

Registration Number	Date	Time	Satisfactory	Un-satisfactory	Remarks
B 7305	2 Oct	1530	X		
B 9763	2 Oct	1540		X	Hood latch KLG
B 8764	2 Oct	1545	X		
B 0010	5 Oct	0900	X		
B 8764	5 Oct	0915	X		
B 7707	5 Oct	1345	X		
B 7706	5 Oct	1400	X		
B 9654	8 Oct	1000	X		
B 8752	8 Oct	1025		X	Door handle KLG
B 3103	8 Oct	1045	X		
B 2758	8 Oct	1600			

Figure 4-8. Sample Tally Checklist.

FIGURE 4-9.

VEHICLE AUTHORIZATION UTILIZATION BOARD (VAUB)

SURVEILLANCE ACTIVITY CHECKLIST

(To be performed (Daily) (Monthly) (Weekly), etc.)

CONTRACT REQUIREMENT	CONTRACT PARAGRAPH NO	METHOD OF SURVEILLANCE	DATE ACCOMPLISHED	WHERE ACCOMPLISHED	COMPLIANCE
The contractor is required to hold a Vehicle Authorization Utilization	F-5 5.1.2.3	The contractor should have in his possession a copy of the VAUB minutes.			
Board (VAUB) quarterly.		There is no specific format for these minutes in AFM 77-310 but should			
		conform to the standard format in AFR 10-1. Minutes should adequately			
		describe and document actions taken by VAUB.			
The contractor is required to develop a vehicle priority list for	F-5 5.1.2.3.5	Verify approved priority list. It should have the board president's			
VAUB approval.		signature and date.			

CHAPTER 5

DOING SURVEILLANCE

5-1. Surveillance Methods. This chapter tells how to do surveillance once the plan is written. It tells how to build a monthly schedule, how to use the surveillance plan, and what to do when there is poor contractor performance. This chapter applies to Quality Assurance Evaluators (QAEs) and contract administrators.

5-2. Building A Schedule. A surveillance plan is organized to facilitate use by the QAE. The QAE is responsible for developing a monthly schedule for activities, based on the surveillance plan's requirements. Complete the Quality Assurance Evaluator Schedule by the last workday of the preceding month and send a copy to the contract administrator and the functional area chief for their information and review. Each QAE builds a schedule by filling in the blocks on the schedule. Specific instructions for filling out the schedule are provided below.

a. Quality Assurance Evaluator Schedule. An example of a surveillance schedule is show in figure 5-1. The left-hand side of the schedule divides the sheet into days of the week. This example shows only a 7-day schedule. The QAE must make up enough sheets to include each day of the month. Along the top of the schedule, insert the items to be checked during the month. Along the bottom of the schedule, indicate the number of observations to be made during the month (that is, how often a MIS is checked, how many samples will be taken, how often a surveillance checklist will be used).

b. Filling In And Updating the Schedule. To fill in the inspection schedule, the QAE refers to the sampling guide for each service being monitored. The sampling guide is used with the random number table to determine the inspections (observations) to be made during the month (see chapter 4, paragraph 4-4).

(1) Contract surveillance must cover all hours of operation. Random observations are scheduled at night, on weekends and holidays when services are performed during these periods. Areas that are monitored on a set schedule (for example, VIMS standards and analysis reports) are included in the monthly schedule. This monthly schedule shows where and what the QAE is monitoring at all times.

QAE Surveillance Schedule

Week of: 1 thru 7 Jan 78

Day	VO Sampling Guide #1	VO Sampling Guide #2	VO Sampling Guide #3	VM Sampling Guide #1	VM Sampling Guide #2	RA Sampling Guide #1	RA Sampling Guide #2	Check AF Forms 15
1 Jun		:2215#9 :2345#54	B7125 B6704	7328 7340 7345				
2 Jun		:0715#63 :0815#2	B4392 B8763	7350 7370 7400	:0900			
3 Jun			LEAVE					
4 Jun	:0915 :0956	:0900#4 :0915#59 :1002#64 :1023#83	B9763 B8794 B1001					
5 Jun	:1101				:1305			X
6 Jun	:0710 :1022 :1303							
7 Jun								
Week Total	6	8	7	6	2			
Month Total	20	32	32	32	5	50		

Figure 5-1. QAE Surveillance Schedule.

"For Official Use Only"

(2) Post any changes to the schedule weekly and send copies to the contract administrator and to the functional area chief. Document and explain the reasons for each change. Actual surveillance activity recorded on the surveillance checklist must be comparable to the monthly schedule.

(3) As updated, one must be able to conduct a complete audit trail from the monthly schedule, to observing the QAE perform sampling, to completion of the surveillance checklist.

(a) There must also be a correlation between contractor performance versus standards, AQLs, checklists and actions taken by the contract administrator. The sample in figure 5-1 shows the schedule for one week. The QAE completes the blank forms, indicating week of (Monday through Sunday), and enters the time, observation, and check (if pertaining to a checklist), in the blocks corresponding to the item and day.

(b) After it is completed and filled in, this form is "FOR OFFICIAL USE ONLY" and must not be shown to the contractor.

5-3. Doing Surveillance. Doing surveillance involves using the surveillance plan called for in the monthly schedule. Use the following procedure to record observations and take action when the contractor's defects exceed the allowable number.

a. Recording Observations. Monthly tally and surveillance checklists are used for each sampling guide and less frequently checked services. They are used to tally information on scheduled observations and defects noted. Each observation in the sample is recorded on the checklists, and the documents then become a formal government record for later reference.

(1) When random sampling guides are used, the tally of observations and defects at the end of each month are compared to the acceptable number of defects appearing in the sampling guide.

(2) The contractor is told each time an error is found during scheduled observations and asked to initial the observation recorded on the checklist.

(3) Errors found in services not scheduled for observation should be brought to the contractor's attention but not used to count as a defect for determining if the AQL has been met.

(4) Checks done with a surveillance activity checklist are likewise recorded.

b. Potential Unsatisfactory Performance. If the sampling guide or surveillance activity checklist indicates that the number of defects is too high, the QAE goes to the decision table for that service indicator.

(1) The QAE must locate the specific service that is unsatisfactory. The table will identify the possible causes of the unsatisfactory performance and list a number of questions which, if answered, will probably pinpoint the source of the problem.

(2) The decision table helps the QAE identify the problem so that, among other things, a meaningful evaluation can be made of the contractor's explanation and corrective action. For example, if the contract specifies a maximum out-of-commission rate for vehicles of 8 percent, and the rate was 10 percent, examination may reveal the excess was caused by excessive vehicle down for parts (VDP). This could have been caused by the government's inability to provide timely parts support.

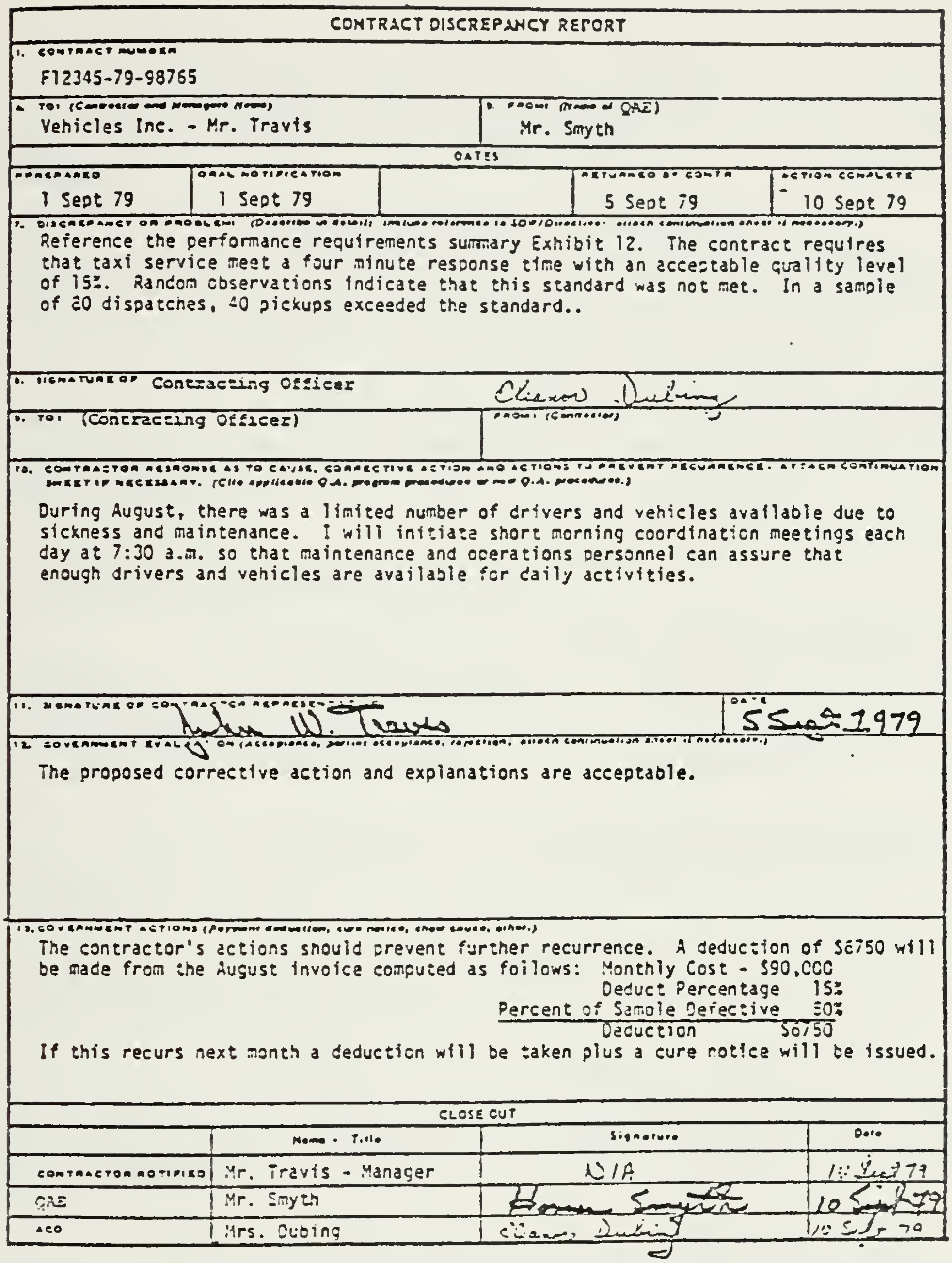
(3) In such a situation, the contractor may not be at fault. If, on the other hand, the excessive VDP was created because the contractor ordered the parts on a routine priority rather than priority, it might be the contractor's fault. The decision tables will assist the QAE in making such a determination.

c. Documenting Unsatisfactory Performance. If performance in any area is judged unsatisfactory, the contractor is required to respond to a Contract Discrepancy Report (CDR). See sample in Figure 5-2.

(1) The QAE prepares the form and sends it to the contracting officer, who signs and sends it to the contractor.

(2) When completed and signed, the report, along with the tally checklist or surveillance activity checklist become the documentation supporting payment, nonpayment, or other necessary action.

5-4. Taking Action. The QAE may check the contractor's performance and document any non-compliance, but only the contracting officer may take formal action against the contractor for unsatisfactory performance.



CONTRACT DISCREPANCY REPORT

1. CONTRACT NUMBER
F12345-79-98765

2. TO: (Contractor and Manager's Name)
Vehicles Inc. - Mr. Travis

3. FROM: (Name of QAE)
Mr. Smyth

DATES

PREPARED	ORAL NOTIFICATION		RETURNED BY CONTR	ACTION COMPLETE
1 Sept 79	1 Sept 79		5 Sept 79	10 Sept 79

7. DISCREPANCY OR PROBLEM (Describe in detail: include reference to SOW/Directive; attach continuation sheet if necessary.)

Reference the performance requirements summary Exhibit 12. The contract requires that taxi service meet a four minute response time with an acceptable quality level of 15%. Random observations indicate that this standard was not met. In a sample of 20 dispatches, 40 pickups exceeded the standard..

8. SIGNATURE OF Contracting Officer Eleanor Dubing

9. TO: (Contracting Officer)

FROM: (Contractor)

10. CONTRACTOR RESPONSE AS TO CAUSE, CORRECTIVE ACTION AND ACTIONS TO PREVENT RECURRENCE. ATTACH CONTINUATION SHEET IF NECESSARY. (Cite applicable Q.A. program procedures or new Q.A. procedures.)

During August, there was a limited number of drivers and vehicles available due to sickness and maintenance. I will initiate short morning coordination meetings each day at 7:30 a.m. so that maintenance and operations personnel can assure that enough drivers and vehicles are available for daily activities.

11. SIGNATURE OF CONTRACTOR REPRESENTATIVE John W. Travis

DATE 5 Sept 1979

12. GOVERNMENT EVALUATION (Acceptance, partial acceptance, rejection; attach continuation sheet if necessary.)

The proposed corrective action and explanations are acceptable.

13. GOVERNMENT ACTIONS (Payment deduction, cure notice, show cause, other.)

The contractor's actions should prevent further recurrence. A deduction of $6750 will be made from the August invoice computed as follows: Monthly Cost - $90,000
Deduct Percentage 15%
Percent of Sample Defective 50%
Deduction $6750

If this recurs next month a deduction will be taken plus a cure notice will be issued.

CLOSE OUT

	Name - Title	Signature	Date
CONTRACTOR NOTIFIED	Mr. Travis - Manager	N/A	10 Sept 79
QAE	Mr. Smyth	Smyth	10 Sept 79
ACO	Mrs. Dubing	Eleanor Dubing	10 Sept 79

a. Ground rules. This section lists the normal steps to be taken by contract administration when the QAE reports these deficiencies. The actions listed are not hard-and-fast rules, and are a minimum. More serious action can be taken sooner.

(1) When the contractor's performance is unsatisfactory as defined in the surveillance plan and a formal action is indicated, the QAE, the functional area chief, and the contract administrator meet to determine what action is appropriate for the specific circumstances.

(2) If a decision is reached not to take a monetary deduction, the reasons are documented. The contracting officer must indicate agreement with the decision by signing the contract discrepancy report or other decision documentation.

b. Actions. Following are the actions normally taken when poor performance is found.

(1) As a rule, the QAE tells the contractor's site manager, in person, when discrepancies occur and asks the contractor to correct the problem. The QAE makes a notation on the tally or surveillance checklist, of the date and time the deficiency was discovered, and has a contractor representative initial the entry on the checklist.

(2) If the number of discrepancies found exceeds the level for satisfactory performance, the QAE uses the decision tables in the surveillance plan to determine the cause(s).

(a) If the government created any of the discrepancies, these are not to be counted against the contractor's performance.

(b) When the government has caused the contractor to perform in an unsatisfactory manner, the QAE prepares a letter to be sent to the responsible organization requesting corrective action be taken. The QAE sends it to the organization through the contracting officer.

(3) When the contractor is responsible for exceeding the limits of satisfactory performance, the contracting officer issues a contract discrepancy report (CDR) to the contractor (see paragraph 5-3c). If the failure is serious enough, issue the CDR at the time of the unsatisfactory performance, rather than at the end of the month.

(4) When a CDR is issued for a specific service the contracting office deducts from the month's payment, an amount up to the percentage indicated in the Performance Requirement Summary exhibit of the contract. Do not delay the deduction until the contractor responds to the CDR. If surveillance was done right and the decision tables used, the unsatisfactory performance is clearly the fault of the contractor. For a specific example of a deduction, see paragraph 5-5.

(5) If the contractor does not achieve satisfactory performance in that specific service by the end of the next month, the contracting officer issues another CDR and deducts the appropriate amount from the contractor's payment.

(6) If a third CDR must be issued, consider issuing a cure notice. (However, a cure notice can be issued sooner, if necessary).

(7) Depending on the contractor's overall performance, the government may issue a Show Cause letter if the reply to a cure notice is unsatisfactory; next consider terminating the contract.

5-5. Deductions For Non-Performance. Through the Inspection of Services clause, the government can deduct from a contractor's payment an amount equal to the services not provided.

a. To do this, the contract administrator must know the major cost categories in the contract and the percentage of cost each service output represents. The percentage cost of each service is found in deduct analysis; see chapter 2, paragraph 2-9. An example of how the deduct formula works is shown in figure 5-3.

b. Suppose the bid schedule showed the monthly contract price for vehicle operations, maintenance, and analysis as shown. The percentage cost of the service output is then found by looking at the Performance Requirements Summary Technical Exhibit in the contract statement of work. In the example, the percentage cost of quality of completed work is 10 percent. This is then multiplied by $100,000 to obtain the maximum amount to deduct.

c. If completed work was unsatisfactory during the month (that is, did not meet performance values) and the percent of the sample found bad was 20 percent, $2000 would be deducted from the payment normally due the contractor.

Deduct Formula (Example)

If: Quality of completed work is unsatisfactory
(AQL of 6.5% exceeded)

and: Contract price is $100,000 per month

and: Quality of completed work deduct percentage is 10%

and: Sample size is 50

and: Number of defects in the sample is 10 (Reject number is 8)

Then: Deduction from the current month's invoice is:

Contract price	=	$100,000
X Deduct percentage	=	.10
		$10,000
X Percent of sample defective		.20
Deduction	=	$ 2,000

Figure 5-3. Deducting for Non-Performance.

d. This amount for quality of completed work is deducted because the contractor failed to provide reliable, uniform services within the assigned performance values. Although some completed work may have met the standard during the month, the acceptable quality level was not met and at least 20 percent of the observations were defective. Hence, the total quality performance requirement has not been achieved. As a consequence, the service output is unsatisfactory.

5-6. Good Performance. When a contractor's quality control program works, good performance results. If the result of a QAE's surveillance shows consistently good performance, the amount of surveillance can be decreased.

a. Reduced Inspection. Inspection can be reduced when the following conditions have been met for a sampling guide.

(1) The preceding 4 lots (that is, the last 4 months) have all been acceptable.

(2) The number of defects in each of the preceding 4 lots is less than one half of the acceptance number. For example, with an AQL of 6.5 percent and a sample size of 32, the acceptance number is 5. If two or less defects were found in each of the last 4 lots, reduced inspection could be used.

(3) The normal sample size is being used.

(4) The functional area chief and the contract administrator agree to use reduced inspection.

b. Reduced Sample Size and Acceptance or Rejection Numbers. Reduced inspection decreases the sample size as shown in figure 5-4. In addition, the acceptance and rejection numbers change as shown in figure 5-5. To make the changes to the existing sampling guide, take the following steps.

(1) Make sure that the original sampling guide was using the normal sample size. To determine this, see Chapter 4, figure 4-3 and compare the lot size with the sample size in the sampling guide.

(2) Find the new sample size by using figure 5-4. Take the lot size and find the new reduced sample size.

(3) Using the AQL in the sampling guide and the new reduced sample size, see figure 5-5 for the new acceptance

Lot Size	Normal Sample Size	Reduced Sample Size
2-8	2	2
9-15	3	2
16-25	5	2
26-50	8	3
51-90	13	5
91-150	20	8
151-280	32	13
281-500	50	20
501-1,200	80	32
1.201-3,200	125	50
3.201-10,000	200	80
10,001-35,000	315	125
35,001-150,000	500	200
150,001-500,000	800	315
500,001 and over	1250	500

Figure 5-4. Reduced Sample Size.

Single sampling plans for reduced inspection

Sample size code letter¹	Sample size	Acceptable Quality Levels (reduced inspection)†																					
		0.010		0.015		0.025		0.040		0.065		0.10		0.15		0.25		0.40		0.65		1.0	
		Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re
A	2	↓		↓		↓		↓		↓		↓		↓		↓		↓		↓		↓	
B	2																						
C	2																						
D	3																						
E	5																					0	1
F	8																			0	1	↑	
G	13																	0	1	↑		↓	
H	20															0	1	↑		↓		0	2
J	32													0	1	↑		↓		0	2	1	3
K	50											0	1	↑		↓		0	2	1	3	1	4
L	80									0	1	↑		↓		0	2	1	3	1	4	2	5
M	125							0	1	↑		↓		0	2	1	3	1	4	2	5	3	6
N	200					0	1	↑		↓		0	2	1	3	1	4	2	5	3	6	5	8
P	315			0	1	↑		↓		0	2	1	3	1	4	2	5	3	6	5	8	7	10
Q	500	0	1	↑		↓		0	2	1	3	1	4	2	5	3	6	5	8	7	10	10	13
R	800	↑				0	2	1	3	1	4	2	5	3	6	5	8	7	10	10	13	↑	

Sample size code letter¹	Sample size	Acceptable Quality Levels (reduced inspection)†																													
		1.5		2.5		4.0		6.5		10		15		25		40		65		100		150		250		400		650		1000	
		Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re
A	2	↓		↓		↓		0	1	↓		↓		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	30	31
B	2					0	1	↑				0	2	1	3	2	4	3	5	5	6	7	8	10	11	14	15	21	22	30	31
C	2			0	1	↑		↓		0	2	1	3	1	4	2	5	3	6	5	8	7	10	10	13	14	17	21	24	↑	
D	3	0	1	↑		↓		0	2	1	3	1	4	2	5	3	6	5	8	7	10	10	13	14	17	21	24	↑			
E	5	↑		↓		0	2	1	3	1	4	2	5	3	6	5	8	7	10	10	13	14	17	21	24	↑					
F	8	↓		0	2	1	3	1	4	2	5	3	6	5	8	7	10	10	13	↑		↑		↑							
G	13	0	2	1	3	1	4	2	5	3	6	5	8	7	10	10	13	↑													
H	20	1	3	1	4	2	5	3	6	5	8	7	10	10	13	↑															
J	32	1	4	2	5	3	6	5	8	7	10	10	13	↑																	
K	50	2	5	3	6	5	8	7	10	10	13	↑																			
L	80	3	6	5	8	7	10	10	13	↑																					
M	125	5	8	7	10	10	13	↑																							
N	200	7	10	10	13	↑																									
P	315	10	13	↑																											
Q	500	↑																													
R	800																														

↓ = Use first sampling plan below arrow. If sample size equals or exceeds lot or batch size, do 100 percent inspection.
↑ = Use first sampling plan above arrow.
Ac = Acceptance number.
Re = Rejection number.
† = If the acceptance number has been exceeded, but the rejection number has not been reached, accept the lot, but reinstate normal inspection

Figure 5-5. MIL-STD-105D Acceptance, Rejection Levels for Reduced Inspection.

and rejection numbers. Note that there is a gap between the acceptance and rejection numbers (for example, sample size 32 and AQL 6.5 percent, accept is 5 and reject is 8). This means that the lot would not be rejected unless 8 defects were found and would be accepted if 5 or less defects were found. However, a number of defects greater than five will be cause for returning to normal inspection (that is, return to the sample size and acceptance and rejection numbers used in the original sampling guide).

c. Returning to Normal Inspection. When reduced inspection is in effect return to normal inspection the next month under the following conditions.

(1) When the number of defects exceeds the acceptance number under reduced sampling or,

(2) The functional area chief and the contract administrator deem it necessary to return to normal inspection.

d. Returning to Reduced Inspection. If during the first month of the return to normal inspection, the number of defects found is again less than 50 percent of the reject level, a return to reduced inspection may be done the next month. If the number of defects found is over 50 percent, then normal sampling must be accomplished until 4 months of less than 50 percent of reject level defects are found.

5-7. Documentation. During the course of the contract the QAE retains a copy of all inspection schedules, tally checklists, and surveillance activity checklists. At the end of the contract period, the QAE forwards these records for inclusion in the contract file. However, when a specific service becomes unsatisfactory during a surveillance period, the inspection documentation supporting the contract discrepancy report is forwarded to the contracting officer no later than 5 working days after the end of the previous performance period.

APPENDIX D

EXCERPTS FROM NAVFAC MO-327

This appendix includes various portions of NAVFAC MO-327 entitled "Service Contracts : Specifications and Surveillance." The first illustration, the Performance Requirements Summary (PRS), is a key and comprehensive surveillance document. It lists each item of work to be performed under the contract, its required standard of performance, the method of inspection for the item, and the acceptable quality level (or allowable deviation).

The next series of illustrations is Chapter 5, Quality Assurance Methods. Each style of inspection, be it planned, random, etc., is explained. Criteria for choosing an appropriate method is provided. Sample service inventory worksheets and surveillance schedules are presented.

The next part of this appendix is Chapter 6, Surveillance. Administrative responsibilities and procedures are listed.

Appendix C is an abbreviated sample quality assurance plan for industrial solid waste collection. Appendix D is an instruction for the utilization of random number tables. Finally, current NAVFAC lot and sample tables are provided although these will be modified by new ONR sampling tables.

TASK	STANDARD & INDICATOR	METHOD OF SURVEILLANCE	AQL
1. Residential waste collection (Sect. 00005, Clause 3.2)	-collection on day specified -no debris -cans left at curb, off street	-planned sampling (primary) -validated complaints (secondary)	3 units per 100
2. Scheduled industrial waste collection (Sect. 00005, Clause 3.3)	-collected within 4 hr of specified time -no debris -containers properly repositioned	-random sampling (primary) -validated complaints (secondary)	10%
3. Unscheduled industrial waste collection (Sect. 00005, Clause 3.4)	-collected within 12 hr of request for pick-up	-validated complaints	5 per month
4. Ash collection (Sect. 00005, Clause 3.5)	-collected within 12 hr of request for pick-up	-validated complaints	3 per month
: : :	: : :	: : :	: : :
9. Quality control program (Sect. 00004, Clause 7)	-QC program established -activity in QC files -QC identified problems resolved	-planned sampling	zero
: : :	: : :	: : :	: : :

FIGURE 4-1
Performance Requirements Summary Table
(Sample)

CHAPTER 5: QUALITY ASSURANCE METHODS

5. GENERAL. This section describes quality assurance evaluation methods used to monitor Contractor performance on service contracts. Before proceeding, the purpose and goals of QA should be discussed.

a. When the Government purchases goods or services, there must be some means provided to attest to the value received for monies spent. To do this, the Government must be able to confirm that the quantity and quality of goods or services received conforms to contract requirements.

b. The recipients of the contracted goods or services, in this case Naval shore activities, are responsible for developing and implementing procedures that assure that the Government is getting what it contracted for. These procedures are referred to as QA.

c. Contractors, on the other hand, are responsible for providing Quality Control (QC). The purpose of QC is to control the service producing process, and to insure that the desired level of output quality is maintained.

5.1 QA PROGRAM.

5.1.1 Traditional Approach. The Navy's traditional approach to surveillance of Service Contracts, often a hit-or-miss affair with no written plan, has not provided adequate quality assurance.

a. The method of surveillance which is claimed to be used most frequently is 100 percent inspection. In reality, however, the inspection is often much less than total, since 100 hundred percent inspection is very costly and not always feasible.

b. Further, traditional surveillance methods have usually focused on the work process (adherence to specified steps and frequencies) rather than on the quality of contract outputs. The net result does not assure satisfactory quality performance.

5.1.2 New QA Approach. The new QA approach, based on a written plan, is keyed to performance oriented specifications.

a. It focuses on the quality of the product delivered by the Contractor and not on the steps taken or procedures used to provide that product.

b. It includes appropriate use of preplanned inspections, validation of complaints, and unscheduled inspections.

c. It provides a structured approach to surveillance that permits management control of QA.

5.1.3 Criteria. There are several criteria for good QA.

a. First, the PWS must be written so that the quantity and quality

of required work outputs are measurable. The development of the PWS and the QA should be viewed as a single process. These documents are interrelated; one defines required work outputs and quality standards while the other defines how work outputs will be observed and measured.

b. QA must provide for adequate and affordable contract surveillance. The depth and detail of surveillance should be geared to the relative importance of the services monitored.

c. QA must have the potential to support corrective action taken by the SCM/ROIC when non-performance or unsatisfactory performance occurs.

d. There are three key ideas that are the basis for contract surveillance.

(1) Outputs. Quality Assurance evaluates the output service provided by the Contractor. The output service can result either from a Contractor developed procedure or from a Government specified procedure. When the output is based on a Contractor developed procedure, the procedure is examined on an exceptions basis; that is, satisfactory service output as specified in the contract normally indicates that the Contractor is using satisfactory procedures. The Government should be concerned with Contractor procedures only when services are not adequate. When the procedure is specified by the Government, compliance with the procedure is the desired output service.

(2) Compliance. Contractor's compliance with contract requirements is monitored through the performance indicators and standards which are specified in the PWS. Performance indicators are measurable attributes of the outputs. A standard is the gauge that Contractor performance is compared against. For example, scheduled trash collection is the work required, one of the indicators of good performance is timeliness, and the standard is trash pick-up is made within 4 hours of the scheduled time.

(3) Cause of Problem. When observed performance indicators show output not to be in compliance with contract requirements, the QAE identifies the cause of the problem. The QAE looks beyond service outputs to determine if the problem is caused by the Government or the Contractor. If the cause of the problem rests with the Government, corrective action must be taken through Government channels and no action is required of the Contractor. If the Contractor is at fault, the Contractor is told to take corrective action; payments to the Contractor are reduced; and a Contracts Discrepancy Report (CDR) may be issued.

5.2 METHODS OF SURVEILLANCE. There are five methods that may be used for contract surveillance.

5.2.1 One Hundred Percent Inspection. One hundred percent inspection requires that output from each and every work occurrence be evaluated. One hundred percent inspection measures the Contractor's true level of performance. It is an expensive and time consuming method which should be used sparingly.

5.2.2 Planned Sampling. Surveillance by planned sampling is designed to evaluate a part but not all of a contract requirement.

a. The number of inspections and the items to be inspected are based on subjective judgment.

b. Planned sampling is useful when requirements at one location are more important than those at other locations; for example, galley dumpsters as opposed to those in a remote administrative area. It is also useful when the Contractor's performance is poor in some spots but better in others.

5.2.3 Random Sampling. Surveillance based on random sampling evaluates part but not all of the work performed. (Appendix D provides details of the mechanics of random sampling.)

a. Using random sampling, any occurrence of work is as likely to be monitored as any other occurrence. The QAE's bias does not affect the specific occurrences of work selected for evaluation since all occurrences of an item of work are assumed to have the same level of importance.

b. This method estimates the Contractor's overall level of performance for a given contract requirement. It is most useful when evaluating items that are repetitive in nature such as janitorial work, grounds maintenance, or service call work.

c. To achieve full benefits, the random sampling method must be applied properly. If misapplied, results will be biased.

5.2.4 Validated Complaints. Validated customer complaints constitute a surveillance method based on customer awareness. Customers, familiar with contract requirements, notify the QAE when there is a case of poor or nonperformance. Upon notification, the QAE investigates the report and, if valid, documents the performance problem.

a. Formal customer complaints are a means of documenting certain kinds of service problems. The way to obtain and document customer complaints needs to be carefully planned by the persons monitoring the service contract.

b. Customer complaints are not random, but when validated by the QAE may be used to deduct money from the Contractor.

c. When random sampling is the chosen method of surveillance, a customer complaint cannot be used to satisfy a random observance. However, it can be used as further evidence of unsatisfactory performance if random sampling shows that the specific service is unsatisfactory. These complaints can be used to decide if other action should be taken.

(1) Getting Customer Complaints. An aggressive customer complaint program, once established, needs to be explained to every organization that receives the Contractor's services. An operating instruction should be given to each organization outlining the customer complaint program, the format and the content of a formal customer complaint, and the action which can be expected from those assigned to watching and managing the service contract. (Appendix E provides a

Customer's Guide for Evaluating Contractor Performance.)

(2) Documenting the Customer Complaint. Normally, each customer complaint is brought, in person or by telephone, to the individual checking contract performance. Enter complaint information into a Customer Complaint Record, similar to the sample show in Figure 5-1. The record contains the following information:

1 Date and time of complaint.

2 Source of complaint - organization or individual.

3 Nature of complaint (narrative description).

4 Contract reference of complaint related services.

5 Valid complaint (Yes or No).

6 Date Contractor informed of complaint.

7 Action taken by Contractor.

8 Signature of the person receiving and validating the complaint.

5.2.5 Unscheduled Inspections. The QAE may conduct impromptu evaluations of contract requirements whenever necessary. This surveillance method (which is not really a method at all) provides no information on the Contractor's overall performance.

5.2.6 Criteria for Method Selection. No firm guidance for method selection can be provided in a manual of this type. Some general guidance on selection criteria are:

a. Population size refers to the number of scheduled or expected occurrences of a contract requirement over a given time period, usually one month. The actual number of occurrences will depend on how a unit of service is defined. Frequency of service at any location may be daily, weekly, etc. Population size is easy to determine for scheduled services. When services are performed on an "as required" basis, population size must be estimated based on historical or projected data. Large homogeneous populations are ideally suited to random sampling.

b. Some contract requirements are more important than others. Some requirements may have an impact on an activity's mission. Others have little or no impact. One hundred percent inspection might be used for "important" contract requirements, a sampling method or customer complaints for "less important requirements", and validated complaints for the "least important requirements".

c. It is easier to talk about instances where surveillance methods are not appropriate.

(1) One-hundred percent inspection is not suited to large populations. It would be time consuming for the QAE and expensive to the Government.

(2) Those services that are important or costly require tight surveillance. Validated complaints do not guarantee that all instances of nonperformance or poor performance will be reported in a timely manner.

(3) If a service is required but individual occurrences are of small importance (for example, emptying a trash can), it is normally not beneficial to invest a great amount in surveillance. One-hundred percent inspection is the most costly of the evaluation methods and should not be used.

(4) If a contract requirement is continuous in nature, 100 percent inspection is not feasible since it would require a QAE to be on-site full time. Examples of continuous requirements are manning a guard post, maintaining a minimum inventory of parts, and fulfilling contractor quality control requirements.

(5) It is not possible to use a surveillance method that requires prescheduling of evaluations for unscheduled service such as responding to Emergency/Service (E/S) calls, processing work orders, and dispatching vehicles. It is possible to schedule retrospective evaluation of Management Information Systems (MIS) outputs such as logs, work orders, or other written records.

d. The choice between planned sampling and random sampling is sometimes difficult.

(1) For example, on a Bus Service Contract it would be very easy to establish a random sampling evaluation plan where the QAE monitors the Contractor's compliance with the established bus schedule. However, this type of surveillance plan would require the QAE to travel to all areas of the bus activity on a random basis, resulting in a large amount of unproductive QAE travel time. Because of the many customer complaints that would result if there were poor bus service, planned sampling is a more attractive surveillance method.

(2) A good rule of thumb in choosing between random and planned sampling is that if all evaluation can be conducted at one work site, random sampling is preferred. If work sites are dispersed, planned sampling should be used. On the other hand, increased QAE travel time may be a good investment if the work item is important.

e. Ideally, QAE's should be staffed to the level required to support the selected QA Program. In reality, the QA program used must accommodate the availability of QAE's. A combination of QA methods should be considered to get the best QA program possible with a given number of QAE's.

5.2.7 Outputs Subject to Surveillance. The QAE must determine what output to inspect to determine the Contractor's overall performance. In many instances a contract requirement will generate several outputs. Evaluating

DATE: TIME:

SOURCE OF COMPLAINT:
Organization -

Individual -

NATURE OF COMPLAINT:

CONTRACT REFERENCE:

COMPLAINT VALIDATED:

Date - Time - By -

CONTRACTOR INFORMED OF COMPLAINT:

Date - Time - By -

ACTION TAKEN BY CONTRACTOR:

WORK REINSPECTED:

Date - Time - By -
Satisfactory -
Unsatisfactory -

FIGURE 5-1
Customer Complaint Record

a single output may provide a reliable indication of the Contractor's overall performance. Types of outputs subject to inspection are:

a. Work Performed. Inspection of all work performed is the best way to evaluate Contractor performance. This requires that the QAE be at the work site during performance of the work, or be there shortly thereafter if results of work performed are visible (e.g., janitorial, grounds, etc.).

b. Records. If the QAE is unable to be at the work site at required times, the inspection of records, work chits, and other documents, (combined with spot checks of actual work performance,) may provide a satisfactory indication of work performance.

c. Management Information System (MIS). MISs usually collect information over a specified period of time. This information can be compared to a contract standard. On the basis of this comparison, performance can be evaluated and the performance for the specified period can be accepted or rejected.

(1) For example, the vehicle down time rate is computed every month. A simple comparison of the rate with the maximum acceptable rate in the SOW explains a great deal about the level of maintenance service supporting the base vehicles.

(2) By way of caution, one is going to use a MIS to check the Contractor, make sure the MIS contains reliable data.

5.2.8 Inventory of Services. Each service requirement that is to be monitored must have an Inventory of Services worksheet prepared. Figure 5-2 is a sample of an inventory worksheet. Inventory worksheets are prepared at the same time the QA Plans are prepared.

a. Purpose. Inventory of Services Worksheets serve two purposes. First and most obvious, these worksheets provide a comprehensive listing of locations receiving a given service. Second, these worksheets are used to select locations for inspection when one of the sampling methods is used.

b. Numbering. Worksheets list each location where a service will be performed. Work occurences should be grouped as daily, weekly, or monthly depending on how surveillance is to be conducted (i.e., daily, weekly, monthly, or other.) Each work occurence, within the group, should then be sequentially numbered.

5.3 QA PLANS. The most important part of implementating a QA program is the development of comprehensive QA Plans. (Appendix C provides a sample of a QA Plan for Scheduled Solid Waste Collection.)

a. QA Plans are documentation of how the QAE intends to monitor specific aspects of Contractor's performance.

b. These plans are the basis for developing QAE schedules and determining required QAE staffing levels.

INVENTORY OF SERVICES FOR: Industrial/Administrative Solid Waste Collection
SURVEILLANCE SCHEDULE: Weekly

NUMBER	LOCATION/IDENTIFICATION	NUMBER	LOCATION/IDENTIFICATION
1	BLDG 1 1		
2	BLDG 1 1		
3	BLDG 2		
4	BLDG 3		
5	BLDG 4 1 North End		
6	BLDG 4 2 North End		
7	BUDG 4 3 South End		
8	BLDG 5		
9	PARK ADMIN BLDG		
10	PARK MAINT BLDG		
11			
12			
13			
14			
15			
16			
17			
18			

FIGURE 5-2
Inventory of Services Worksheet
(Sample)

c. QA Plans are developed to cover all items shown in the Performance Requirement Summary Table. (A single plan may cover more than one item if surveillance of those items is compatible.)

d. QA Plans are monitored by the QAE throughout the life of the contract. Once established, they do not tend to change.

e. Recommended formats for QA Plans are described below. (A sample of a QA Plan is provided in Appendix C.)

f. Each QA Plan established should have an evaluation worksheet, or checklist. This worksheet, or checklist, is used to document surveillance results. Figure 5-3 is a sample of an Evaluation Worksheet for refuse collection.

5.3.1 100 Percent Inspection.

a. Contract Requirement. Contract requirements, identified in the Performance Requirements Summary Table (see Figure 4-1), are listed along with the performance indicators and standards. Specific clauses in the SOW establishing these requirements also are listed.

SURVEILLANCE SCHEDULE FOR INDUSTRIAL/ADMINSISTRATIVE AREA SOLID WASTE COLLECTION
CONTRACT NUMBER: ____________________

FOR: 22 June 1981 QAE: I. Peak

BLDG/ LOCATION	EMPTIED	DEBRIS	POSITION	CONDITION	COMMENT
Bldg. #14	P	P	P	P	
Bldg. #19	P	F	P	P	Trash spilled on pavement when dumpster emptied
Bldg. #28	P	P	P	P	
Bldg. #41	F	P	P	P	Container overflowing, scheduled pick-up yesterday
Bldg. #43	P	P	P	P	
Area # 3	P	P	P	F	Container lid will not close
Area #11	P	P	P	P	
Area #19	P	P	P	P	
Area #23	P	P	P	P	

FIGURE 5-3
Evaluation Worksheet for Scheduled
Industrial/Administrative Area Solid Waste Collection

b. Primary Method of Surveillance. The primary method of evaluation is 100 percent inspection.

c. AQL. AQL's are best stated as a percentage.

d. Quantity of Work. Define a unit (i.e., single occurrence) of work, and determine the number of units to be performed during the surveillance period. Performance of each unit will be evaluated.

e. Level of Evaluation. This is not applicable.

f. Sample Size. This is not applicable.

g. Sample Selection Procedure. This is not applicable.

h. Evaluation Procedure. List any procedures or checklists used when doing the inspection. Evaluation procedures should be in enough detail to allow others to continue the same manner of inspection using the same evaluation criteria.

i. Analysis of Results. The analysis of evaluation results for 100 percent inspection is straight forward. The Observed Defect Rate (ODR) is computed as follows:

$$\text{ODR} = \frac{\text{Number of Defects}}{\text{Number Units of Work}} \times 100$$

5.3.2 Planned Sampling.

a. Contract Requirement. Contract requirements, identified in the Performance Requirements Summary Table (see Figure 4-1), are listed along with the performance indicators and standards. Specific clauses in the SOW establishing these requirement are listed.

b. Primary Method of Surveillance. The primary method of surveillance is planned sampling. Validated complaints are a good supportive surveillance method.

c. AQL. AQL's should be stated as an absolute value (e.g. 3 per surveillance period).

d. Quantity of Work. Define a unit (i.e. single occurrence) of work and determine the number of units to be performed during the surveillance period.

e. Level of Surveillance. If more than one level of surveillance is desired, it is recommended that three carefully defined levels of surveillance be identified and that criteria be established for switching from one level to another. These surveillance levels are:

Normal - Applied to good but not exceptional contractor performance. This level of surveillance to be used when contract is first implemented.

Reduced - Applied in the case of exceptional contractor performance.

Increased - Applied in the case of poor contractor performance.

f. Sample Size. Determination of sample size for planned sampling is subjective. In order to provide consistent surveillance, the rationale for selecting a sample size must be identified. Sample size will vary depending on the level of surveillance used.

g. Sample Selection Criteria. The criteria for sample selection must be documented and applied consistently from surveillance period to surveillance period. If there is no consistency, trends in contractor performance cannot be detected.

h. Evaluation Procedure. List any procedures or checklists used when doing inspection. Evaluation procedures should be in enough detail to allow others to continue the same manner of inspection using the same evaluation criteria.

i. Analysis of Results. The Observed Defect Rate (ODR) for a planned inspection is the total number of defects documented during the surveillance period. All defects detected by customer complaints and unschedule inspections are included in this total. The ODR is:

ODR = number of documented defects.

5.3.3 Random Sampling. This method, in order to be effective, must be properly applied. (Appendix D describes the mechanics of random sampling.)

a. Contract Requirement. Contract requirements, identified in the Performance Requirements Summary Table (see Figure 4-1), are listed along with the performance indicators and standards. Specific clauses in the SOW establishing these requirements are listed.

b. Primary Method of Surveillance. Random sampling is the primary evaluation method. Validated complaints and unscheduled inspections may be considered as secondary methods. WARNING information collected by other surveillance methods can never be combined with information gathered by random sampling. Evaluation results collected by other methods serve only as supportive data.

c. AQL. For evaluation by random sampling, AQL's are stated as a percentage and predefined as 5, 10, 15, 20 or 25 percent. Sample sizes for AQL's of 15, 20 and 25 percent are defined in the Sample Size Tables but are not generally recommended.

d. Quantity of Work Performed. Define a unit of output for each service that is subject to inspection. It is important to accurately determine the quantity of work performed in order to select the appropriate sample size.

e. Level of Surveillance. The level of surveillance will be set at one of three levels, and the level of surveillance may be adjusted monthly depending on the Contractor's performance.

(1) Initial level of surveillance is normal surveillance, level II.

(2) Reduced Surveillance. If contractor performance has been "excellent," the level of surveillance could be reduced to level I.

(3) Increased surveillance. If, on the other hand, performance during the past surveillance period was poor, surveillance could be increased to level III.

f. Sample Size. Sample size for random sampling is determined by use of tables and is a function of the AQL, quantity of work performed and level of surveillance. (Sample size table are provided in Appendix D.)

g. Sampling Procedure. To assure that samples are selected completely at random, a random number table must be used. (This table is provided as part of Appendix E.)

h. Evaluation Process. List any procedures or checklists used when doing the inspection. Evaluation procedures should be in enough detail to allow others to continue the same manner of inspection using the same evaluation criteria.

i. Analysis of Results. Analysis for random sampling will consist of computing the Observed Defect Rate (ODR) for the past surveillance period.

$$\text{ODR} = \frac{\text{Number of Defects}}{\text{Number Evaluations Conducted}} \times 100$$

The number of defects used in computing the ODR is derived from the samping process. Defects detected through validated complaints or unscheduled inspections cannot be used.

5.3.4 Validated Customer Complaints A Validated Complaint is any customer complaint identifying a Contractor defect that the QAE has validated by documentation based on an on-site visit. Complaints not validated may not be used.

a. Contract Requirement. Contract requirements, identified in the Performance Requirements Summary Table (see Figure 4-1), are listed along with the performance indicators and standards. Specific clauses in the SOW establishing these requirements are listed.

b. Primary Method of Surveillance. The primary method of surveillance is validated complaints. A secondary evaluation method that may be used is unscheduled inspections.

c. AQL. AQL's for Validated Complaints should be stated in terms of number of occurrences per surveillance period.

d. Quantity of Work. Although the quantity of work will not have direct effect on validated complaint evaluations, this information is useful when putting results in perspective.

e. Level of Surveillance. This is not applicable.

f. Sample Size. This is not applicable.

g. Sample Selection Criteria. This is not applicable.

h. Evaluation Procedure. Document how validation of complaints is to be performed. Evaluation procedures should be in enough detail to allow others to continue the same manner of inspection using the same evaluation criteria.

i. Analysis of Results. Determine the number of validated complaints for the past surveillance period. If there is a good customer complaint program, changes in the number of complaints per surveillance period may be useful in detecting changes in the Contractor's overall level of performance. The Observed Defect Rate (ODR) for validated complaints is:

$$\text{ODR} = \text{number of documented defects}$$

5.3.5 Unscheduled Inspections. Unscheduled inspections do not have formal QA Plans. This type of surveillance should be used as a secondary, or supportive, surveillance method and as such, be subject to the QA Plan of the primary method.

CHAPTER 6 SURVEILLANCE

6. GENERAL. The key to assuring satisfactory performance from service contracts is adequate Government surveillance of Contractor performance. Hit-or-miss surveillance by untrained personnel is an invitation to poor performance. The more prone (historically) a particular type of work is to shoddy performance, the more necessary it is to assign an adequate number of trained and qualified personnel (QAE's) who are familiar with the contract surveillance. The QAE is a key person in service contract management. The QAE serves as the eyes and ears of the SCM and as such must demonstrate a large degree of common sense since many facets of the job are subjective and open to criticism. NAVFAC Quality Assurance Evaluator (QAE) Training Manual, MO-326.2, provides in-depth information on QAE duties and the surveillance process.

6.1 SURVEILLANCE PROCESS. The surveillance process is a system composed of many key elements. Figure 6-1 illustrates this system.

6.1.1 Inputs. The key input to surveillance is contract requirements. These requirements dictate what work the Contractor is to perform and what the QAE is to evaluate. Next in importance is the Contractor's work schedule. The schedule is necessary in order for the QAE to know when work, which is not scheduled by contract requirements, is to be performed. The intensity of surveillance is influenced to a degree by the Contractor's past performance. During the surveillance period the number and type of customer complaints received will affect the QAE's schedule.

6.1.2 Process. The process, as displayed in Figure 6-1, may be divided into four main parts: planning for surveillance, conducting surveillance, analysis of surveillance results, and taking action based on those results.

a. Planning for surveillance includes QA Plans and Monthly QAE Schedules. QA Plans are developed prior to contract award and in most cases remain unaltered throughout the life of the contract. Monthly QAE Surveillance Schedules are developed, based on QA Plans, at the start of each surveillance period (a period is usually one month).

b. Contract surveillance is conducted in accordance with QA Plans and the QA Monthly Schedule. If, during the surveillance period, major discrepencies are noted (and documented), the QAE will alert the SCM that action should be taken.

c. At the end of the surveillance period, "documented" surveillance results are analyzed to determine the Contractor's overall level of performance.

d. Based on the Contractor's performance, there are several courses of action that may be taken. First, deductions will be made for all observed and documented cases of non-compliance, regardless of the Contractor's overall level of performance. Other specific actions that may be taken include: "jaw boning" the Contractor; issuance of a Contract Discrepancy Report (CDR), Cure Notice or Show Cause Notice; and contract termination. The person taking action may be the SCM, ROIC, OIC, or Commander, NAVFAC. Regardless of the course of action, GOOD DOCUMENTATION IS REQUIRED.

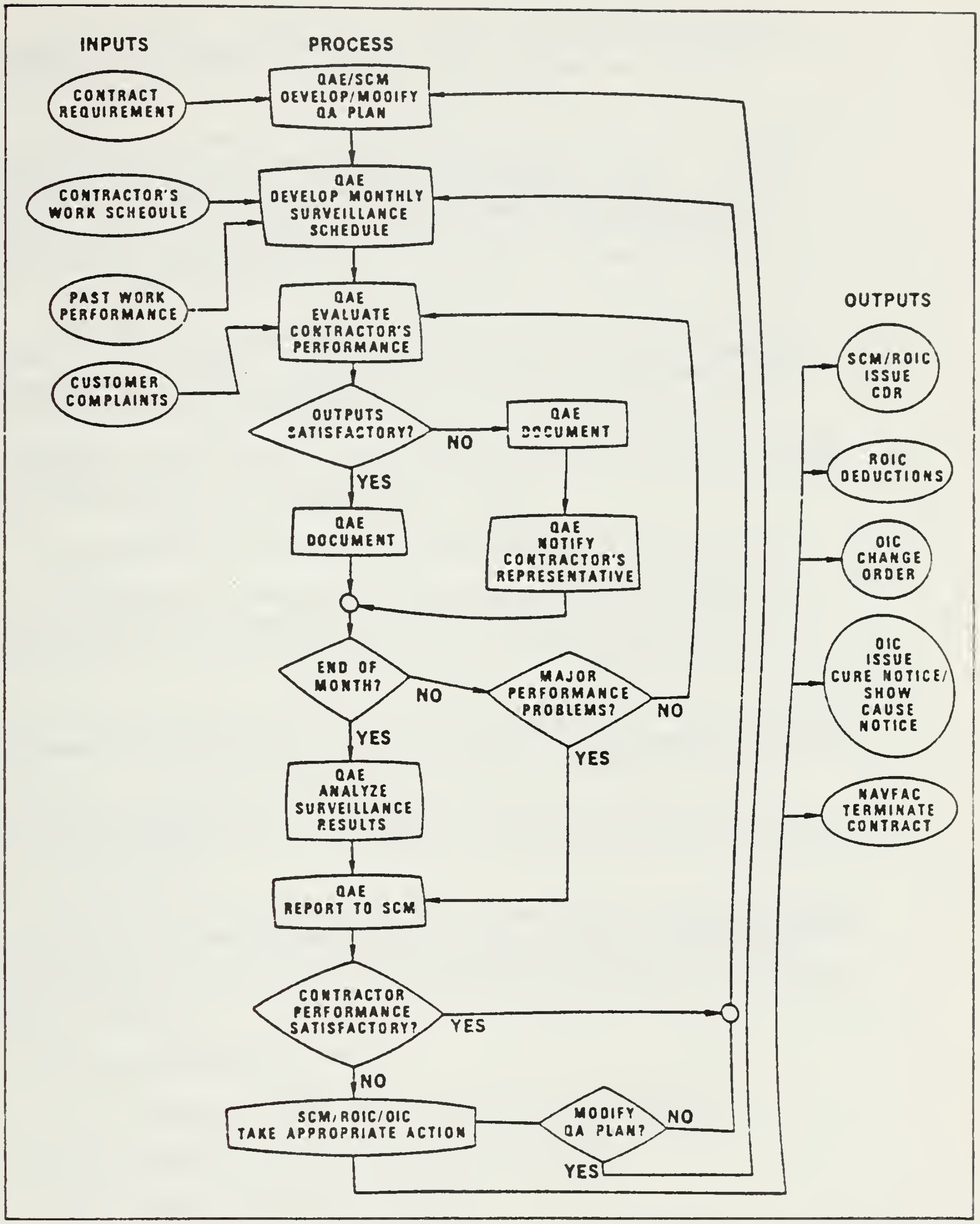

INPUTS
PROCESS
OUTPUTS
CONTRACT REQUIREMENT
QAE/SCM DEVELOP/MODIFY QA PLAN
CONTRACTOR'S WORK SCHEDULE
QAE DEVELOP MONTHLY SURVEILLANCE SCHEDULE
PAST WORK PERFORMANCE
QAE EVALUATE CONTRACTOR'S PERFORMANCE
CUSTOMER COMPLAINTS
OUTPUTS SATISFACTORY?
NO
QAE DOCUMENT
YES
QAE DOCUMENT
QAE NOTIFY CONTRACTOR'S REPRESENTATIVE
END OF MONTH?
NO
MAJOR PERFORMANCE PROBLEMS?
NO
YES
YES
QAE ANALYZE SURVEILLANCE RESULTS
QAE REPORT TO SCM
CONTRACTOR PERFORMANCE SATISFACTORY?
YES
NO
SCM/ROIC/OIC TAKE APPROPRIATE ACTION
MODIFY QA PLAN?
NO
YES
SCM/ROIC ISSUE CDR
ROIC DEDUCTIONS
OIC CHANGE ORDER
OIC ISSUE CURE NOTICE/ SHOW CAUSE NOTICE
NAVFAC TERMINATE CONTRACT

FIGURE 6-1
Contract Surveillance Process

6.2 QUALITY ASSURANCE EVALUATOR (QAE). QAE's must have qualifications in both the technical aspects of the contracted function and contract surveillance methods.

a. Technical expertise for evaluating work quality is found within the organizational component that would be responsible for work accomplishment if it were to be performed by Government forces. The QAE should be drawn from this component. (In the case of CA conversions the activity will retain 4 percent of the organizational component being converted to contract performance. This 4 percent is intended for contract management - i.e. SCM and QAE duties.)

b. The TRCO is the person usually responsible for selecting QAE's. Once selected for QAE duties, candidate QAE's must be trained in contract surveillance methods. This training is available through the QAE Training Course offered periodically by NAVFAC Engineering Field Divisions (EFD's).

6.2.1 Authority. QAE derives his authority by delegation from the SCM and acts as his representative when authorized. In no case can the SCM delegate authority to the QAE that he himself does not have.

a. Delegation of authority is by letter from the SCM to the QAE.

b. The QAE has no authority to allow deviations from essential contract requirements, but when authorized by his superior, he may approve minor deviations not involving change in contract time, price, or basic design.

c. The QAE has no authority to direct or interfere with the methods of performance by the Contractor or to issue instructions directly to any of the Contractor's personnel unless the methods being used are unsafe.

6.2.2 Responsibilities. The QAE, because of his familiarity with the contract, the Contractor, and the customer, is involved with several aspects of Service Contracting.

a. Specific QAE responsibilities will depend upon local conditions, size of the contract, QAE collateral duties, etc. Assigned responsibilities should be agreed upon by the SCM, the QAE, the TRCO, and other interested parties before the contract start date. Assigned QAE responsibilities should be stated in writing.

b. Specific QAE duties are to:

- Review plans and specifications prior to IFB/RFP;
- Conduct Contractor pre-bid site visits;
- Assist in pre-award surveys;
- Review Contractor schedules and advise SCM of acceptability;

- Attend pre-bid and pre-start conferences;
- Coordinate provision of Government furnished space, utilities, equipment and material;
- Prepare Quality Assurance Plans;
- Prepare surveillance schedules;
- Perform surveillance and document Contractor's performance;
- Conduct surveillance on accomplishment of re-performed work;
- Monitor labor, safety and security practices, and document results;
- Recommend payment deductions for unsatisfactory work to SCM; and
- Assist in the preparation of Government estimate for change orders.

6.2.3 STAFFING. An adequate level of QAE staffing is required to make any QA program work well. There are two approaches to staffing for contract surveillance: (a) write the QA program to accommodate the number of QAE's currently available, or (b) to write the QA program to provide the desired level of surveillance and staff to that program. Obviously the latter is the preferred approach. The chief problem is converting the desired level of surveillance into manhour requirements. QA Plans, and the subsequent QAE Schedules, provide a means of determining QAE manhour requirements. These documents, if properly prepared, will identify QAE staffing requirements for contract surveillance.

6.3 QAE SCHEDULE. The development of an effective evaluation schedule should be of the utmost importance to the QAE. The evaluation schedule allows the QAE to plot where he should be on any given day of the week. By developing a balanced inspection schedule, a QAE can be much more effective in his job. It allows the QAE to plan his workday in advance to the best advantage. It also allows him to utilize his time and eliminate some potentially wasteful actions (for example, excessive travel time between inspections). QAE Schedules serve three purposes,they are:

a. Optimizing Time. The QAE will use his established schedule to plan his work. By making maximum use of a good schedule, the QAE will optimize use of his time.

b. Management Control. The SCM is provided a copy of each QAE Schedule. The SCM has the responsibility to see that surveillance of service contracts is properly conducted. The QAE Schedule provides him the information necessary to monitor the QA program.

c. Audit. The QAE Schedule, along with completed evaluation reports, provide an audit trail for contract surveillance. The established schedule as updated during execution, should reflect what was actually accomplished.

6.3.1 Schedule Development. QAE schedules are based on established QA Plans. When developing monthly schedules, the QAE will use the evaluation worksheets developed for that month. As he prepares his schedule he may find it convenient to combine surveillance requirements in order to streamline the daily schedule. When developing schedules it may be necessary to modify QA Plans in order to achieve the most effective allocation of QAE time. However, plans based on random sampling CANNOT be modified in this manner.

a. The Schedule. An example of a QAE's Schedule is shown in Figure 6-2. This example shows only a 6-day schedule. The QAE must make up enough sheets to include each day of the month. Along the top of the schedule, insert the items to be checked during the month. Along the bottom of the schedule, indicate the number of observations to be made during the month.

b. Filling In and Updating the Schedule. To fill in the inspection schedule, the QAE refers to the QA Plans for each service being monitored. The QA Plan is used to determine the inspections (observations) to be made during the month.

(1) Contract surveillance must cover all hours of operation. Random observations are scheduled at night, on weekends, and on holidays when services are performed during these periods. Areas that are monitored on a set schedule are included in the monthly schedule. This monthly schedule shows where and what the QAE is monitoring at all times.

(2) Post any changes to the schedule weekly, and send copies to the SCM and to the TRCO. Document and explain the reasons for each change. Actual surveillance activity recorded on the evaluation worksheets must be comparable to the monthly schedule.

(3) As updated, one must be able to conduct a complete audit trail from the monthly schedule, to observing the QAE perform sampling, to completion of the evaluation worksheet.

(4) After the schedule is completed and filled in, this form is "FOR OFFICIAL USE ONLY" and must not be shown to the Contractor.

c. Review and Approval. The QAE's Schedule must be submitted to the SCM for review and approval. The QAE is responsible for posting changes, as they occur, to the schedule throughout the month. This schedule becomes a formal part of the surveillance documentation, and, as such, it must be auditable.

6.4 SURVEILLANCE. Contract surveillance involves using the QA Plan called for in the monthly schedule.

6.4.1 Performance of Surveillance. Contract surveillance is performed in accordance with the QA Plan: method of surveillance, sample size/selection, and evaluation critieria are specified in this plan.

a. The QA program must provide an adequate and consistent level of surveillance. It is important that QA plan be followed and deviations documented in order that this program can be audited.

b. Timing of Inspections:

(1) In some cases inspection will have to be conducted during the period of work performance. For example:

- When the Contractor is performing maintenance on a piece of equipment, the QAE may have to inspect the work before the equipment is fully reassembled.

- If work on a building's electrical or plumbing systems is performed, the QAE would have to inspect before siding or dry wall is replaced.

- To determine if the Contractor is maintaining a base shuttle bus schedule, the QAE must be at the stop at the scheduled time.

(2) For daily services, such as custodial services, the QAE should conduct inspections shortly after work performance, but prior to occupant use.

(3) In many cases services performed will provide outputs of a lasting nature and may be inspected days after actual performance. Work, such as painting, resurfacing of roads, glass replacement, tree pruning, etc., are examples of this type of work.

(4) Some services performed by the Contractor may be inspectable at any time; for example: if a grounds maintenance contract requires a level of maintenance (vs. frequency of work), the QAE will be monitoring the condition of the grounds rather then work performed (e.g. grass to be between 2 and 4 inches in height.) A watch standing requirement such as guard service or fire protection requires Contractor personnel on duty 24 hours a day.

c. It is good practice to make surveillance findings, good or bad, available to the Contractor on a daily basis. Provided information does not relieve the Contractor of his Quality Assurance efforts but is intended to keep the Contractor advised of the Government's perception of the quality of performed work.

6.4.2 Documentation. Just as services required of the Contractor have outputs, Government surveillance has outputs. One of the key outputs is documentation, which consists of: the QAE's monthly schedule, completed evaluation worksheets, records of customer complaints, and any other material that reflects the quality/quantity of Contractor performance.

QAE: ______________________ SCHEDULE FOR WEEK OF : June 22 thru 27

	DAY					
TIME	MON	TUE	WEN	THU	FRI	SAT
0700	P-INSP MESS HALL #2	P-INSP MESS HALL #4			R-INSP BLDG. 1,9 13,20,31	
0800		Meet with SCM, ROIC, AND CONT. REP TO DISCUSS: CHANGE ORDERS	MONITOR TRASH COLLECTION IN RES. AREA A	R-INSP BLDG. 11, 14,18,20	MONITOR TRASH COLLECTION IN RES. AREA B	
0900	P-INSP CONT. QC FILE					
1000				P-INSP WASH RACK		
1100						
1200	LUNCH	LUNCH	LUNCH	LUNCH		
1300	PAPER WORK IN OFFICE		PINSP SANITARY LANDFILL OPERATIONS		LUNCH	
1400					MEET WITH SCM	
1500	R-INSP BLDG. 1 5,32,41	R-INSP AREA 5,9 11,15				
1600			R-INSP AREAS 3,5, 7,17,19	P-INSP COMMISARY	P-INSP MESS HALL #2	
1700						
1800						
1900						

NOTE: P-INSP = Planned Inspections
R-INST = Random Inspections

FIGURE 6-2
QAE Surveillance Schedule
(Sample)

a. Recording Observations. Evaluation Worksheets are used for each QA Plan. They are used to tally information on scheduled observations and noted defects. Each observation in the sample is recorded on the Worksheet, and the Worksheets then become a formal Government record.

b. Potential Unsatisfactory Performance. If surveillance indicates that the number of defects for the month may exceed the AQL, the QAE should try to identify and document the cause of the problem.

(1) The cause of the problem may lie with the Government.

(a) Is delivery of Government-provided material or equipment the problem?

(b) Are Government employees (civilian or military) disrupting the Contractor's work efforts?

(2) If the cause of the problem lies with the Contractor, the QAE should determine why.

(a) Does the Contractor have an adequate number of people, or properly trained people, at the work site?

(b) Is Contractor work supervision adequate?

(c) Is the Contractor's QC program identifying these problems? (It should be.)

(d) Are the proper equipment and materials being used?

(e) Is the work method used capable of producing the required output?

c. During the course of the contract the QAE retains a copy of all QAE Schedules, Evaluation Worksheets, and checklists. At the end of the contract period, the QAE forwards these records for inclusion in the contract file. However, when a specific service becomes unsatisfactory during a surveillance period, a copy of the inspection documentation supporting the contract discrepancy is forwarded to the SCM/ROIC for action.

d. As mentioned above it is good practice to keep the Contractor appraised of surveillance results. One way to do this is to provide the Contractor's Representative a copy of the Evaluation Worksheet. It is recommended that Contractor's Representative initial the original Evaluation Worksheet indicating that he has received a copy.

6.5 SURVEILLANCE RESULTS. It is the QAE's duty to make QA evaluation results known to the SCM who then is responsible for taking the appropriate action. At the end of the month the QAE will tally the results for all Evaluation Worksheets, checklists, etc., to determine the Contractor's overall performance with respect to each QA Plan.

6.5.1 Excellent Performance. If the Contractor has performed in the best possible manner and there were few defects noted (Observed Defect Rate (ODR) less than 1/2 the AQL), the QAE might suggest that:

a. The Contractor should be notified by the SCM that he is performing satisfactorily.

b. The level of surveillance might be reduced.

c. Deductions will be made on all documented defects.

6.5.2 Good Performance. When a Contractor's quality control program works, good performance results. If the result of a QAE's surveillance shows consistently good performance, the amount of surveillance can be decreased.

a. Deductions will be made on all documented defects.

b. Reduced Surveillance. Inspection can be reduced when the following conditions have been met for a surveillance period.

(1) The preceding month's work (or number of months as specified in the QA Plan) has been acceptable.

(2) The percentage of defects in the preceding month(s) is less than one half of the AQL.

(3) The normal sample size is being used.

(4) The TRCO and the SCM agree to use reduced inspection.

c. Returning to Normal Surveillance. When reduced surveillance is in effect, return to normal inspection the next month under the following conditions:

(1) When the percentage of defects exceeds the AQL under reduced sampling, or

(2) The TRCO and the SCM deem it necessary to return to normal inspection.

6.5.3 Questionable Performance. An outcome of questionable performance can only result when random sampling is the surveillance method used.

a. Random sampling procedures take into consideration potential errors in results. Since random sampling only provides an estimate of the true defect rate, a margin for error must be used. This is done by specifying the accuracy desired of the ODR, as compared to the true defect rate. Accuracy is defined to be one half of the AQL. If, for example, the AQL was 10 percent, accuracy would be 5 percent. It is this gray area, where the ODR falls between the AQL and 1.5 times the AQL, that results are questionable.

b. The recommended actions for questionable performance are:

(1) Deduct for all documented defects.

(2) If there are a significant number of validated customer complaints and/or defects detected by unscheduled inspections, issue a Contract Discrepancy Report (CDR).

(3) Go to an increased level of evaluation.

6.5.4 Poor Performance. If the Contractor has displayed poor performance (i.e., the ODR exceeds the AQL, or for random sampling the ODR exceeds 1.5 times the AQL), then the following are the actions normally taken in addition to deductions.

a. If the QAE first determines that the Government created any of the discrepancies, these are not to be counted against the Contractor's performance. When the Government has caused the Contractor to perform in an unsatisfactory manner, the QAE prepares a letter to be sent to the responsible organization, requesting corrective action. The QAE sends it to the responsible organization through the SCM.

b. If the Government did not cause the discrepancy, the QAE tells the Contractor's site manager, in person, when discrepancies occur and asks the Contractor to correct the problem. The QAE makes a notation on the Evaluation Worksheet of the date and time the deficiency was discovered and has a Contractor's representative initial the entry on the checklist.

c. Increased Surveillance. The level of surveillance can be increased when the following conditions have been met for a sampling period:

(1) The preceding surveillance period (last month's inspection) has been unsatisfactory (ODR exceeds AQL).

(2) Normal sample size is being used.

(3) The TRCO and the SCM agree to increased inspection.

(4) Use the Sample Size shown in Table III, Appendix E, (or go to 100 percent inspection)

(5) Return to Normal Sample Size if after one month the ODR is less than the AQL.

d. When the Contractor is responsible for failing to meet the limits of satisfactory performance (the AQL), the SCM issues a Contract Discrepancy Report (CDR) to the Contractor (discussed in 6.6.2 below). If the failure is serious enough, issue the CDR at the time of the unsatisfactory performance rather than at the end of the month.

e. If the Contractor does not achieve satisfactory performance in that specific service by the end of the next month, the SCM issues another CDR, and the ROIC may call in the Contractor Representative for a personal review of the problem.

f. If a third CDR must be issued, the ROIC should consider issuing a cure notice. (However, a cure notice can be issued sooner, if necessary.)

g. Depending on the Contractor's overall performance, the Government may issue a Show Cause letter if the reply to a cure notice is unsatisfactory. (EFD 02 approval is required.)

6.6 TAKING ACTION. The QAE may check the Contractor's performance and document any non-compliance, but only the OIC may take formal action against the Contractor for unsatisfactory performance. This section lists the normal steps to be taken by contract administration when the QAE reports these deficiencies. The actions listed are not hard-and-fast rules and represent a minimum level of action. More serious action can be taken sooner.

6.6.1 Deductions. NAVFAC policy is that deductions will be made for each observed and documented defect. Extrapolated deductions based on random sampling will not be used.

a. The QAE makes a recommendation on the amount of payment deductions to be made based on documented deficiencies multiplied by the price shown in the Schedule of Deductions, or in the Items of Bid for indefinite quantity work items, and the amount of liquidated damages shown in the "Consequences of Contractor's Failure to Perform" clause.

b. When the Contractor's performance is unsatisfactory, i.e., exceeds the AQL as defined in the QA Plan and a formal action is indicated, the QAE, the TRCO, the SCM, the ROIC, and the Contract Specialist meet to determine what action is appropriate.

c. If a decision is reached to not take a monetary deduction, the reasons are to be documented. The ROIC must indicate agreement with the decision by signing the decision documentation.

d. Example Deductions:

(1) Example 1. The QAE has conducted surveillance of a contract requirement using planned sampling supported by validated customer complaints. At the end of the month results are:

- Number of inspections conducted - 100
- Number of defects found through planned inspection - 3
- Number of customer complaints - 15
- Number of complaints validated - 11

(a) The Contractor was not given the opportunity to perform the work due to time constraints.

(b) Observed Defect Rate (ODR) is 14 (3 + 11). Assuming AQL was 10 defects/month, the Contractor performance is POOR. A CDR should be issued.

(c) The established price for each unit of work is $10 (taken from the Schedule of Deductions). Recommended deduction is $140 plus an additional 10 percent for administrative costs which are allowed under the "CONTRACTOR's CONSEQUENCES OF FAILURE TO PERFORM" clause of Section 00004. Total amount recommended for deduction is $154.

(2) Example 2. Random sampling has been the method used to monitor the Contractor's performance. Results at the end of the month are:

- o Number of inspections conducted - 87
- o Number of defects found through random sampling - 6
- o Number of customer complaints - 5
- o Number of complaints validated - 2
- o Number of defects documented by Unscheduled Inspections - 2

(a) The Contractor was not given the opportunity to perform the work due to time constraints.

(b) The ODR is 6.9 percent (6 divided by 87). NOTE: The 2 defects identified by customer complaints and the 2 day unscheduled inspections are not included in the ODR computation.

(c) The established price for each work occurrence is $15. Recommended deduction is $150 ($15 X 10 defects; all defects are used for deduction calculations), plus $15 for administrative costs. (The "CONSEQUENCES OF CONTRACTOR'S FAILURE TO PERFORM" Clause, Section 00003 allows an additional 10 percent for defective work that is either re-performed by the Contractor or left unperformed.) Total amount recommended for deduction is $165.

(3) Example 3. The QAE has used 100 percent inspection to evaluate the Contractor's performance. At the end of the month results are:

- o Number of inspections conducted - 85
- o Number of defects found - 7
- o Number of defects corrected by Contractor - 4
- o Number of defects corrected by Government Employees - 3

(a) The nature of required work was such that it could be re-performed, and it was necessary that all work be accomplished during the month.

(b) The ODR is 7. Since this work was very important to the activity's mission the AQL was set at zero. The Contractor's overall performance is POOR. A CDR should be issued.

(c) The established price per unit of work is $500. The recommended deduction is $2000 based on the following:

- Work re-performed by the Contractor is subject to a 10 percent deduction for administrative costs as specified in the "CONSEQUENCES OF CONTRACTOR'S FAILURE TO PERFORM" clause, Section 00003. (In this case administrative cost is taken to mean the cost of re-inspection; therefore, the Government must be able to show that re-inspection was performed.) This amounts to $200 ($500 x 4 x 10 percent).

- Work performed by Government employees is subject to 20 percent deduction to reflect the cost of the liquidated damages as specified in the "CONSEQUENCES OF CONTRACTOR'S FAILURE TO PERFORM" clause, Section 00003. If the work in question was bid lump sum, and the Contractor's invoice reflects that work, the cost of that work must be deducted. This amounts to $1800: $300 ($500 X 3 x 20 percent) plus $1500 ($500 X 3) for the cost of the work. (NOTE: If the work in question was bid on an indefinite quantity work item and the Contractor's invoice did not reflect the work in question, only $800 would be deducted for that work performed by Government employees.)

6.6.2 Contract Discrepancy Report (CDR). CDR's are written to identify documented cases of poor Contractor performance. The Contractor, upon receiving a CDR, must identify, in writing, how future occurrences of the problem will be prevented (*i.e.*, the corrective action he intends to take). Based on the Contractor's response, the Government may or may not take further action.

a. When the Contractor's overall performance for any given contract requirement is classified as "poor", the QAE should recommend to the SCM that a CDR (Figure 6-3) be issued.

b. The QAE is responsible for identifying the problem that caused the poor performance. This information is not relayed to the Contractor. The QAE will use this information to evaluate the Contractor's response. The Contractor should have a Quality Control Program that gives him feedback on his performance.

c. If the Contractor's response is likely to correct the problem, the QAE should recommend to the SCM that further Government action is not required with the exception of an increased level of surveillance. If the response is not likely to correct the problem, the QAE should identify why it is not adequate and recommend further action to be taken by the Government.

1. CONTRACT NUMBER:

2. TO: (Contractor & Manager's Name) 3. FROM: (Name of SCM/ROIC)

4. DISCREPANCY OR PROBLEM: (Describe in detail: Include reference to SOW Directive: Attach continuation sheet if necessary.)

5. SIGNATURE: (SCM/ROIC) 6. DATE:

7. TO: (Contracting Officer) FROM: (Contractor)

8. CONTRACTOR RESPONSE: (Contractor's proposed solution to correct future occurrences of the problem, use Continuation Sheet if necessary)

9. SIGNATURE: (Contractor Representative) DATE:

10. GOVERNMENT EVALUATION: (Is the Contractor's response a viable solution to the problem?)

11. GOVERNMENT ACTIONS: (Does the Government accept, propose modification, or reject the Contractor's response?)

12. CLOSE OUT:
QAE Signature: Date:
SCM Signature: Date:
ROIC Signature: Date:

FIGURE 6-3
Contract Discrepancy Report
(Sample)

APPENDIX C

SAMPLE QUALITY ASSURANCE (QA) PLAN
QA PLAN FOR SCHEDULED INDUSTRIAL SOLID WASTE COLLECTION

1. CONTRACT REQUIREMENT. Clause 3.3 of Section 00005 specifies the requirements for scheduled industrial solid waste collection. The contractor is required to establish collection schedules. Collection standards are:

- Scheduled pick-ups are made within four hours of the established time.
- Pick-ups are made outside of normal rush hours (or other site specific time).
- Noise levels not to exceed 90 dBA as measured on a general purpose sound level meter, (ANSI standard S1.4-1961).
- No more then five pieces of debris within 15 yard radius of container after pick-up.
- Containers re-positioned within five feet of specified location.

2. PRIMARY METHOD OF SURVEILLANCE. Random sampling supported by customer complaints.

3. ACCEPTABLE QUALITY LEVEL (AQL). 10 percent.

4. QUANTITY OF WORK. Appendix H to the contract specifies 85 sites for scheduled industrial solid waste collection. The contractor supplied collection schedule specifies 50 of these sites for weekly collection and the remaining 35 sites on a twice weekly schedule. This gives a total of 480 work occurrences per month ((50 X 4) + (35 X 4 X 2) = 480).

5. LEVEL OF SURVEILLANCE. Normal surveillance (Level II) is recommended initially. If contractor performance is good (i.e., Observed Defect Rate (ODR) is 1/2 the AQL, or less), for 2 months in a row, then reduced surveillance (Level I) should be considered.

If the Contractor's performance is questionable for the past month (i.e., ODR greater than the AQL but less than or equal to 1.5 times the AQL) and reduced surveillance was used, return to normal surveillance.

If Contractor performance is unsatisfactory in any month (i.e., ODR is greater than 1.5 times the AQL), then increased surveillance (Level III) should be implemented for the following month.

6. SAMPLE SIZE. Using the Sample Size Tables, the following sample sizes are required for an AQL of 10 percent and a population of 480:

LEVEL OF SURVEILLANCE	NO. PER MONTH	NO. PER WEEK*
Normal (Level II)	109	28
Reduced (Level I)	34	9
Increased (Level III)	178	45

*Assumes four weeks per month.

7. SAMPLE SELECTION PROCEDURE. Since random sampling is the method of evaluation to be used, sample selection will be by a random process. The selection process is as follows:

a. Collection sites are numbered from 1 to 120.

b. On a monthly basis select four sets of random numbers of sizes indicated above (*i.e.*, 28 for Level II surveillance). Each set of numbers may have duplicate numbers selected for those sites on a twice weekly collection schedule. Numbers may be duplicated between sets.

c. Each set of numbers selected will be matched against the numbered sites. These sites are the collection sites to be monitored for each respective week.

d. Weekly evaluation worksheets are prepared for selected sites.

8. EVALUATION PROCEDURES. The QAE will visit each selected site on the day collection is scheduled. Site visits, in general, should be conducted four hours after scheduled pick-up time. The QAE should arrange to be at the site at the time of pick-up if there have been problems reported with respect to debris or noise.

9. ANALYSIS OF RESULTS. At the end of the month, the QAE is to count the number of pick-ups classified as unsatisfactory and compute an overall defect rate for the month. The Observed Defect Rate (ODR) is the number of unsatisfactory pick-ups divided by the sample size.

$$\text{ODR} = \frac{(\text{Total \# U's})}{(\text{Total \# U's + S's})} \times 100$$

Since this QA Plan is based on random sampling, unsatisfactory pick-ups detected by customer complaints cannot be used in computing the ODR. Unsatisfactory pick-ups detected by customer complaints will be used in determining a course of action when the contractor's observed performance is questionable (*i.e.*, ODR greater than the AQL but less than 1.5 times the AQL).

APPENDIX D

RANDOM SAMPLING

1. GENERAL. Random sampling is a surveillance method based on statistical theory. The key element of random sampling is that each and every occurrence of work has an equal chance of being evaluated. In order to achieve the desired end results, knowledge of the Contractor's overall performance based on evaluation of only part of the work, surveillance by random sampling must be applied properly. Key elements of random sampling are:

a. Sample size is specified for a given population to achieve a predetermined level of statistical accuracy.

b. The sample of work occurrences selected for evaluation must be selected by a random process in which each occurrence has equal chance for selection.

c. Once an evaluation schedule has established, it must be followed through the surveillance period (i.e., monthly schedules).

d. Surveillance data gathered by other methods (i.e., customer complaints and unscheduled inspections) can not be combined with data gathered by random sampling.

e. Assessment of the Contractor's overall performance, projected from the observed condition of the sample, will always have the potential to be in error. Statements as to overall performance should be stated as "The Contractor's overall defect rate is in excess of X %". (Where "X" equals the observed defect rate minus one half the AQL - ex. ODR (9.2%) - 1/2 AQL (10%) = 4.2%.)

2. MECHANICS OF RANDOM SAMPLING. Random sampling is a structured approach based on statistics to contract surveillance. As such, there is a set procedure in its application. The mechanics of applying random sampling are as follows.

3. POPULATION. The total number of work occurrences for a given function that are to be performed during the surveillance period must be known or accurately estimated. The Inventory of Service Worksheet is used to determine population size.

a. When work is scheduled, population size is easy to determine.

Example: Activity X has 80 dumpsters, 70 are emptied weekly and 10 are emptied twice a week. The population, total number of work occurrences per month, is 360 (70x4) + (10x4x2).

b. When work is unscheduled, population size must be estimated.

Example: The number of service requests for the past six months were:

Jan	321
Feb	301
Mar	295
Apr	337
May	340
Jun	320
Total	1914

The average number of service calls per month has been 319 (1914/6). This would be the expected population for service calls for next month unless there is some known reason to expect a change.

4. SAMPLE SIZE. Sample size requirements are based on AQL, population size, and level of surveillance. Sample size tables are used to determine sample size. Tables for normal surveillance, reduced surveillance, and increased surveillance are attached.

a. Select the table with the desired level of surveillance (Tables I, II, or III).

b. Select the column with the required AQL (.05, .10, .15, .20, or .25).

c. Select the row that is closest to the population size, preferably the next largest entry.

d. The number indicated by the row and column selection is the sample size required for surveillance in one surveillance period.

(1) Daily surveillance requirements will be determined by dividing the required period's sample size by the number of days that surveillance is to be conducted.

(2) Weekly surveillance requirements will be determined by dividing the required sample size by the number of weeks in a period.

(3) When computing weekly or daily sample sizes, always round up to the next whole number (e.g. 45 monthly samples required and 20 work days per month results in a daily sample size of 3 - (45/20) = 2.25 and rounded up results to 3).

5. Sample Selection. The final thing to be decided in sampling is how the sample will be drawn. The objective in the method is to insure that the sample is random (that is, that all services have an equal chance of being selected). To achieve random selection, use a random numbers table as explained in the following examples. (A random numbers table, Table IV, is attached). Most items will fall into one of these examples.

a. Use Of The Random Numbers Table. The random numbers in Table IV are arranged in groups of two.

(1) To use the table, begin by picking at a random a group of numbers on any page of the table. This is usually done by closing the eyes and pointing with a pencil or finger to some initial group.

(2) To identify additional random numbers, follow a pattern. Go along a given line to its end and then along the next line to its end and so on through the table until enough numbers have been selected or until the table ends.

(3) If the table ends and there are still more numbers to select, go back to the beginning of the table and continue using the same pattern. Use various patterns alternately, for example, use lines for one sample, use columns for the next sample, and use a diagonal pattern for the third sample.

b. How To Use the Random Numbers Table To Identify a Random Sample of Consecutively Numbered Work orders. Suppose one has to identify a random sample of 97 work orders for evaluation. (Sample size is based on a population of 319 using normal surveillance.) This can be done at the beginning of the month (before the work orders are written) or at the end of the month.

(1) If there are, or might be, 319 consecutively numbered work orders to select from, then one begins by listing the lowest work order number (known or projected). This could be #001, or possibly 443, or any other sequentially assigned number. List the highest work order number (known or projected); in this case, it could be #319 or 762. For this example, use work orders numbered #443 to 762.

(a) Select 97 three digit numbers from Table IV using a consistent pattern.

(b) If random numbers selected are not between 443 and 762, discard the number outside the designated range and select a new number.

(2) For example, using the initial entry on Table IV we would select number 441. This number is too low. The next number, going down the column, is 343 again too low. The third number selected is 749. This number falls in the range of work order number (443-762) subject to inspection. So work order number 749 is selected to be inspected. The next work order number selected is 523.

(3) This process would be continued until three work orders are selected.

c. How To Use The Random Numbers Table To Identify A Random Sample From A Group of Items. If a number of items need to be sampled that are not consecutively numbered, the simplest solution is to list the identifiers, for all the items in a column, on a piece of lined paper.

(1) Next, number the lines consecutively, beginning with the number one. Now use the random number table to draw the sample from the line numbers. A selected line number leads to the identifier located on that line, and that identifier tells which item to sample. For example, if one chooses to sample a set of work orders with attached sales slips, one is not going to have to have a set of consecutively numbered work orders because not every work order has a sales slip attached.

(2) List the work orders with sales slips in a column, number each line in the column, and randomly select enough line numbers to make up the sample.

d. How To Use The Random Numbers Table To Identify a Random Sample of Days. Suppose one wants to identify four days in the month on which to sample something. The days of the month can be numbered 01 to 31 (or less, as appropriate).

(1) It is best to use a starting point different from the one used in the previous example. For the purpose of this example, it is being used again.

(2) One can move down the column from number to number until the first number between 01 and 31 is spotted. In this case, it is 22. Thus the 22nd day of the month is selected for sampling.

(3) Continuing in this fashion, one discovers that 11 is the next number selected. This number is disregarded. Proceed in this manner until the four days for sampling have been identified. In our example, the 4 days selected would be 22, 11, 10 and 24.

(4) If it is not desirable to sample on weekends, discard those days selected that happen to fall on a weekend and continue that selection until the proper number of days has been selected.

e. How To Use the Random Numbers Table To Identify a Random Sample of Times of Day. If one wants to select random times of day to sample a service such as taxi or bus service, use the 24 hour clock.

(1) If there are any constraints during each 24-hour period, take them into consideration. For example, suppose that base bus service operates between 0700 and 2300. Convert these times to minutes (e.g. 0700 = 0, 0410 = 130, 1215 = 315, etc.) Again, using Table IV and selecting three digit numbers and proceeding across the line from the initial number, one comes to 441, or 1421 hrs, as the first random time.

(2) The next random number is 343, or 1243 hrs. The number is good and so one schedules an observation for 1243 hrs.

(3) Proceed in this manner until the desired number of sample times have been identified.

f. How To Insure Variety in the Use of the Random Numbers Table. The use of variety in the random number table ensures that detectable patterns do not occur.

(1) Success in using the tables requires consistency but also variety. The above information should ensure that the tables are properly used and that the sample is randomly drawn.

g. Other Random Numbers Generating Methods. The use of a hand held calculator with a random number generating capability is an alternative to the use of random numbers table. Using this type of calculator the QAE would enter the minimum value and maximum value and numbers generated would always be within the desired range.

TABLE D-1
SAMPLE SIZE REQUIREMENTS FOR REDUCED SURVEILLANCE
(SURVEILLANCE LEVEL I)

POPULATION			AQL		
SIZE	.05	.10	.15	.20	.25
50	31	21	16	11	9
75	34	25	17	13	10
100	44	27	18	13	10
125	49	28	19	14	10
150	52	30	20	14	10
175	55	30	20	14	10
200	57	31	20	14	11
225	59	32	20	14	11
250	60	32	21	14	11
275	61	32	21	15	11
300	63	33	21	15	11
325	64	33	21	15	11
350	64	33	21	15	11
375	65	33	21	15	11
400	66	34	21	15	11
425	67	34	21	15	11
450	67	34	21	15	11
475	68	34	21	15	11
500	68	34	21	15	11
550	69	34	22	15	11
600	70	34	22	15	11
650	70	35	22	15	11
700	71	35	22	15	11
750	71	35	22	15	11
800	72	35	22	15	11
850	72	35	22	15	11
900	73	35	22	15	11
950	73	35	22	15	11
1000	73	35	22	15	11
1100	74	35	22	15	11
1200	74	35	22	15	11
1300	74	36	22	15	11
1400	75	36	22	15	11
1500	75	36	22	15	11
1600	75	36	22	15	11
1700	75	36	22	15	11
1800	76	36	22	15	11
1900	76	36	22	15	11
2000	76	36	22	15	11
2500	76	36	22	15	11
3000	77	36	22	15	11
3500	77	36	22	15	11
4000	77	36	22	15	11
4500	77	36	22	15	11
5000	78	36	22	15	11
6000	78	36	22	15	11
7000	78	36	22	15	11
8000	78	36	22	15	11
9000	78	36	22	15	11
10000	78	36	22	15	11

TABLE D-2
SAMPLE SIZE REQUIREMENTS FOR NORMAL SURVEILLANCE
(SURVEILLANCE LEVEL II)

POPULATION SIZE	AQL				
	.05	.10	.15	.20	.25
50	43	37	32	27	23
75	60	49	40	32	27
100	76	58	46	37	29
125	89	66	51	40	31
150	101	72	54	42	32
175	111	78	57	43	33
200	121	82	60	45	34
225	129	86	62	46	35
250	137	89	63	47	35
275	144	92	65	48	36
300	151	95	66	48	36
325	157	97	67	49	37
350	162	99	68	49	37
375	167	101	69	50	37
400	172	103	70	50	37
425	176	105	71	51	38
450	181	106	71	51	38
475	184	107	72	51	38
500	188	109	72	52	38
550	195	111	73	52	38
600	201	113	74	52	39
650	206	114	75	53	39
700	211	116	75	53	39
750	215	117	76	53	39
800	219	118	76	54	39
850	222	119	77	54	39
900	226	120	77	54	39
950	229	121	78	54	39
1000	231	122	78	54	39
1100	236	123	78	55	40
1200	241	124	79	55	40
1300	244	125	79	55	40
1400	248	126	80	55	40
1500	251	127	80	55	40
1600	253	128	80	55	40
1700	256	128	80	55	40
1800	258	129	81	56	40
1900	260	129	81	56	40
2000	262	130	81	56	40
2500	269	131	82	56	40
3000	274	132	82	56	41
3500	277	133	82	56	41
4000	280	134	83	57	41
4500	282	134	83	57	41
5000	284	135	83	57	41
6000	287	135	83	57	41
7000	289	136	83	57	41
8000	290	136	84	57	41
9000	291	136	84	57	41
10000	292	137	84	57	41

TABLE D-3

SAMPLE SIZE REQUIREMENTS FOR INCREASED SURVEILLANCE
(SURVEILLANCE LEVEL III)

POPULATION			AQL		
SIZE	.05	.10	.15	.20	.25
50	47	43	39	35	31
75	67	59	52	46	39
100	86	74	63	54	45
125	104	87	72	60	50
150	121	98	80	65	53
175	136	108	86	69	56
200	151	116	92	73	58
225	164	124	97	76	60
250	177	132	101	79	62
275	189	138	105	81	63
300	201	144	108	83	64
325	211	150	111	85	65
350	222	155	114	86	66
375	231	159	116	88	67
400	241	164	119	89	68
425	249	168	121	90	69
450	258	172	123	91	69
475	266	175	124	92	70
500	273	178	126	93	70
550	288	184	129	95	71
600	301	189	132	96	72
650	313	194	134	97	73
700	324	198	136	98	73
750	334	202	138	99	74
800	344	206	139	100	74
850	352	209	141	101	75
900	361	212	142	101	75
950	368	214	143	102	75
1000	376	217	144	103	76
1100	389	221	146	103	76
1200	401	225	148	104	77
1300	411	228	149	105	77
1400	421	231	150	106	77
1500	429	234	151	106	77
1600	437	236	152	107	78
1700	444	238	153	107	78
1800	451	240	154	107	78
1900	457	241	155	108	78
2000	462	243	155	108	78
2500	485	249	158	109	79
3000	501	253	159	110	80
3500	513	256	161	111	80
4000	523	259	161	111	80
4500	530	260	162	111	80
5000	537	262	163	112	80
6000	546	264	164	112	81
7000	554	266	164	112	81
8000	559	267	165	113	81
9000	563	268	165	113	81
10000	567	269	165	113	81

TABLE D-4
SHORT TABLE OF RANDOM NUMBERS

44	19	15	32	63	55	87	77	33	29	45	00	31
34	39	80	62	24	33	81	67	28	11	34	79	26
74	97	80	30	65	07	71	30	01	84	47	45	89
22	14	61	60	86	38	33	71	13	33	72	08	16
40	03	96	40	03	47	24	60	09	21	21	18	00
52	33	76	44	56	15	47	75	78	73	78	19	87
37	59	20	40	93	17	82	24	19	90	80	87	32
11	02	55	57	48	84	74	36	22	67	19	20	15
10	33	79	26	34	54	71	33	89	74	68	48	23
67	59	28	25	47	89	11	65	65	20	42	23	96
98	50	75	20	09	18	54	34	68	02	54	87	23
24	43	23	72	80	64	34	27	23	46	15	36	10
39	91	63	18	38	27	10	78	88	84	42	32	00
74	62	19	67	54	18	28	92	33	69	98	96	74
91	03	35	60	81	16	61	97	25	14	78	21	22
42	57	66	76	72	91	03	63	48	46	44	01	33
06	36	63	06	15	03	72	38	01	58	25	37	66
92	70	96	70	89	80	87	14	25	49	25	94	62
91	08	88	53	52	13	04	82	23	00	26	36	47
68	85	97	74	47	53	90	05	90	84	87	48	25
59	54	13	09	13	80	42	29	63	03	24	64	12
39	18	32	69	33	46	58	19	34	03	59	28	97
67	43	31	09	12	60	19	57	63	78	11	80	10
61	75	37	19	56	90	75	39	03	56	49	92	72
78	10	91	11	00	63	19	63	74	58	69	03	51
93	23	71	58	09	78	08	03	07	71	79	32	25
37	55	48	82	63	89	92	59	14	72	19	17	22
62	13	11	71	17	23	29	25	13	85	33	35	07
29	89	97	47	03	13	20	86	22	45	59	98	64
16	94	85	82	89	07	17	30	29	89	39	80	98
04	93	10	59	75	12	98	84	60	93	68	16	87
95	71	43	68	97	18	85	17	13	08	00	50	77
86	05	39	14	35	48	68	18	36	57	09	62	40
59	30	60	10	41	31	00	69	63	77	01	89	94
05	45	35	40	54	03	98	96	76	27	77	34	80
71	85	17	74	66	27	85	19	55	56	51	36	48
80	20	32	80	98	00	40	92	57	51	52	83	14
13	50	78	02	73	39	66	82	01	28	67	51	75
67	92	65	41	45	36	77	96	46	21	14	39	56
72	56	73	44	26	04	62	81	15	35	79	26	99
28	86	85	64	94	11	58	78	45	36	34	45	91
69	57	40	80	44	94	60	82	94	93	98	01	48
71	20	03	30	79	25	74	17	78	34	54	45	04
89	98	55	98	22	45	12	49	82	71	57	33	28
58	74	82	81	14	02	01	05	77	94	65	57	70
50	54	73	81	91	07	81	26	25	45	49	61	22
49	33	72	90	10	20	65	28	44	63	95	86	75
11	85	01	43	65	02	85	69	56	88	34	29	64
34	22	46	41	84	74	27	02	57	77	47	93	72
42	64	64	58	22	75	81	74	91	48	46	18	34
84	05	72	90	44	27	78	22	07	62	17	35	34
23	09	94	00	80	55	31	63	27	91	70	74	13
04	90	51	27	61	34	63	87	44	13	50	56	48

APPENDIX E

EXTRAPOLATED DEDUCTIONS BASED ON SAMPLING TECHNIQUES

Given:
AQL : 6.5%; lot size : 450 units; sample : 50 units
Ten defectives were found in the sample.
Maximum contract payment per month: $10,000
Payment percentage for the service (from PRS): x 5%
Maximum payment for acceptable service: $500
Unit price ($500 divided by 450 units) $1.11
10 defectives exceed a reject number of 8:
Defective percentage in sample: 20%
Percentage of sample found acceptable: 80%
Credit for corrected samples: 2.2%
Acceptable percentage: 82.2%
Payment for acceptable service: $411

Figure E.1 Air Force Deductions Under Random Sampling.

This figure shows how deductions would normally be made when a contractor exceeds the AQL for any month's performance, This example illustrates how credits would be applied when work is allowed to be reperformed. Without reperformance, the above final payment would instead be $400.

AQL : 5%; lot size : 50 units; defectives : 5 units.	
Maximum contract payment per month:	$10,000
Maximum payment percentage for specific service:	x 4%
Maximum payment for acceptable service:	$400
Unit price ($400 divided by 50)	$8
5 defectives exceed a reject number of 3:	
Percentage of lot found acceptable:	90%
Payment for acceptable performance:	$360

Figure E.2 Air Force Deductions Based on Planned Sampling.

This figure illustrates how deductions are made when planned sampling procedures are utilized. Deductions would not be taken if the defectives observed were less than the reject number of three. When the AQL for a month's performance is exceeded, the contractor should be notified by means of a discrepancy report. If successive discrepancy reports must be prepared, a Show Cause or Cure Notice may be required.

All items are subject to 100% inspection.	
Cost of required services:	$5000
Total number of work units(lot size):	100
Unit price ($5000 divided by 100 units):	$50
Sample size:	100
Observed nonconforming items:	6
Units reworked at government option:	3
Units not creditable for payment:	3
Total units creditable for payment:	97
Percentage of contract price due:	97%
Dollar value due:	$4850
Liquidated damages at 10% of nonconforming service (.10 x 6 x $50):	$30
Actual amount paid:	$4820

Figure E.3 NAVFAC Payment Under 100 Percent Inspection.

This figure illustrates NAVFAC's method of deductions under 100% inspection. Liquidated damages are assessed at 10% of the value of initial observed defect rates in the sample. Items may be resubmitted for credit towards final payment.

Random sampling is being utilized.

All defectives are reworked.

Cost of required services:	$5000
Total work units (lot size):	1000
Unit price ($5000 divided by 1000 units)	$5
Sample size:	122
Observed nonconforming:	11
Percentage nonconforming:	9%
AQL:	10%
Units reworked at government option:	11
Total units creditable for payment:	1000
Percentage of contract price due:	100%
Dollar value due:	$5000
Liquidated damages at 10% of nonconforming service (.10 x 11 x $5):	$5.5
Actual amount paid:	$4994.5

Figure E.4 NAVFAC Random Sampling Deductions Where AQL is Not Exceeded.

Under this scheme, random sampling procedures are being utilized. As before, liquidated damages are assessed against all nonconforming items that are observed. If all items are reworked, as in this case, full payment less any liquidated damages is made.

Random sampling procedures are being utilized.

Cost of required service	$5000
Total number of work units (lot size):	1000
Unit price ($5000 divided by 1000)	$5
Sample size:	122
Observed nonconforming units:	11
Threshold (AQL):	10%
Observed percentage nonconforming:	9%
Units reworked (at Government option):	6
Units not creditable for payment:	5
Total units creditable for payment:	995
Percentage of contract price due:	99.5%
Dollar value due:	$4975
Liquidated damages (10% of nonconforming items, or .10 x 11 x $5)	$5.5
Actual amount paid:	$4969.5

Figure E.5 NAVFAC Deductions when defectives are less than AQL and some are reworked.

This figure shows that random sampling is the inspection, and that not all of the units found defective were reworked. Thus, deductions for liquidated damages and defective observed sample items are taken. This procedure is not utilized by the Air Force.

Random sampling procedures are being utilized.

Some defectives are reworked in the allotted time.

Cost of required services:	$5000
Total number of work units (lot size):	1000
Unit price ($5000 divided by 1000 units):	$5
Sample size:	122
Observed defectives nonconforming:	17
Percentage nonconforming:	14%
Threshold (AQL):	10%
Extrapolation of defective percentage to obtain total acceptable units:	860
Units reworked (at Government option):	14
Total units creditable for payment:	874
Percentage of contract price due:	87.4%
Dollar value due:	$4390
Liquidated damages at 10% of the value of nonconforming services based on extrapolated percentages (.14 x 1000 x 5 x .1):	$70
Actual amount paid:	$4320

Figure E.6 **NAVFAC Deductions where AQL is exceeded and some defectives are reworked.**

This illustration shows that when random sampling reveals observed defect rates in the sample to be greater than the specified AQL, liquidated damages and payment deductions use sample defect percentage. Units that are resubmitted are credited only after the extrapolation calculations are complete. This procedure, in concert with reliable statistical techniques, should be most effective in gaining contractor attention to defective performance.

Planned sampling inspection is in effect.

Cost of required service:	$5000
Total number of work units (lot size):	1000
Unit price ($5000 divided by 1000):	$5
Sample size (as desired):	122
Observed nonconforming units:	12
Units reworked within allotted time:	6
Total units creditable for payment:	994
Percentage of contract price due: (Deduct only for observed defects)	99.4%
Dollar value due:	$4970
Liquidated damages at 10% of value of nonconforming services:	$6
Actual amount paid:	$4964

Figure E.7 NAVFAC Deductions under planned sampling procedures.

The figure shows the deduction procedures for planned sampling.

APPENDIX F

INSPECTION RESOURCE ESTIMATION WORKSHEETS DEVELOPED BY LANTDIV

The following three worksheets are examples of QAE resource estimating worksheets that have been developed and promulgated by the Atlantic Division, Naval Facilities Engineering Command. These worksheets apply for planned, random and 100 percent inspection methods and should result in fairly accurate estimates of QAE requirements. All monthly totals can be accumulated to obtain annual hour requirements, and thus provide an estimate of personnel ceiling points that should either be retained or requested. This methodology would provide future benefits in that agencies might be able to accumulate actual hours expended for inspection during the performance period of CA contracts, and thus result in a manhour estimating factor for various work requirements that are performed under the contract.

Items listed in the contract requirements columns should correspond to work items that are listed on the performance requirements summaries (PRS's).

QAE WORKLOAD CALCULATIONS PLANNED SAMPLING

INSTRUCTIONS: Fill in the contract requirement, quantity of work and level of surveillance from Performance Requirement Summary Table. Calculate the number of inspections. Using the estimated hours per inspection, calculate the number of hours of inspection required per month. Refer to MO-327 for suggested surveillance levels.

Contract Requirement	Quantity of Work	Level of Surveillance	Number of Inspecs.	Hrs. per Inspec.	Monthly Hrs. of Inspecs.

QAE WORKLOAD CALCULATIONS 100% INSPECTION

INSTRUCTIONS: Fill in the contract requirement and quantity of work from Performance Requirement Summary Table. The level of surveillance is 100%. The quantity of work is the number of inspections. Using the estimated hours per inspection, calculate the number of hours of inspection required per month.

Contract Requirement	Quantity of Work	Level of Surveillance	Number of Inspecs.	Hrs. per Inspec.	Monthly Hrs. of Inspecs.
		100%			
		100%			
		100%			
		100%			
		100%			
		100%			
		100%			
		100%			
		100%			
		100%			
		100%			
		100%			
		100%			
		100%			
		100%			
		100%			
		100%			
		100%			

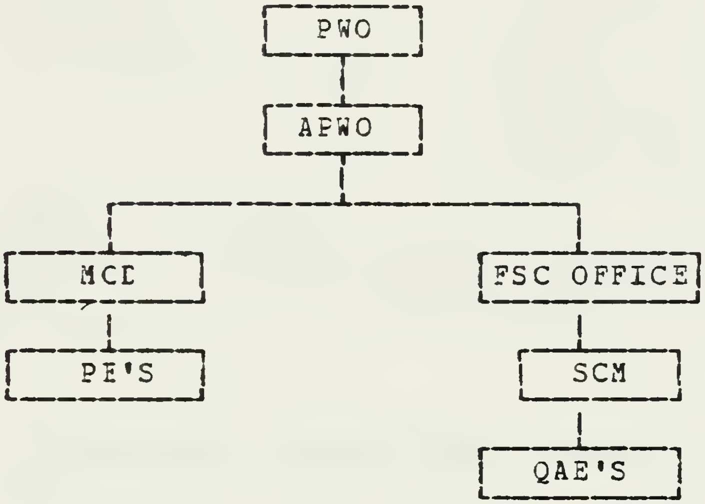
QAE WORKLOAD CALCULATIONS RANDOM SAMPLING

INSTRUCTIONS: Fill in the contract requirement, quantity of work and the number of inspections to be performed from Performance Requirement Summary Table. Indicate surveillance level. Using the estimated hours per inspection, calculate the number of hours of inspection required per month. Refer to MO-327 for recommended surveillance levels and associated sample size requirements.

Contract Requirement	Quantity of Work	Level of Surveillance	Number of Inspecs.	Hrs. per Inspec.	Monthly Hrs. of Inspecs.

APPENDIX G

VARIOUS CA CONTRACT ADMINISTRATION ORGANIZATIONS STUDIED BY NORTHDIV

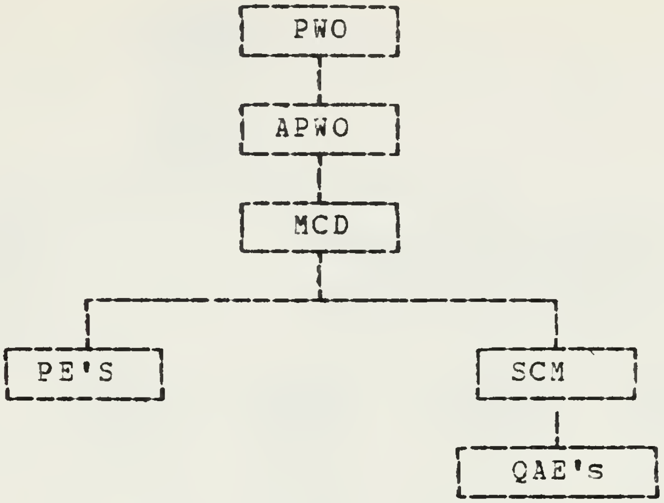


Legend

PWC = Public Works Officer
APWO = Assistant Public Works Officer
FSC Office = Facilities Service Contract Office
MCD = Maintenance Control Division
SCM = Service Contract Manager
PE'S = Planners and Estimators
QAE's = Quality Assurance Evaluators

This organization locates the FSC office as a completely centralized activity division.

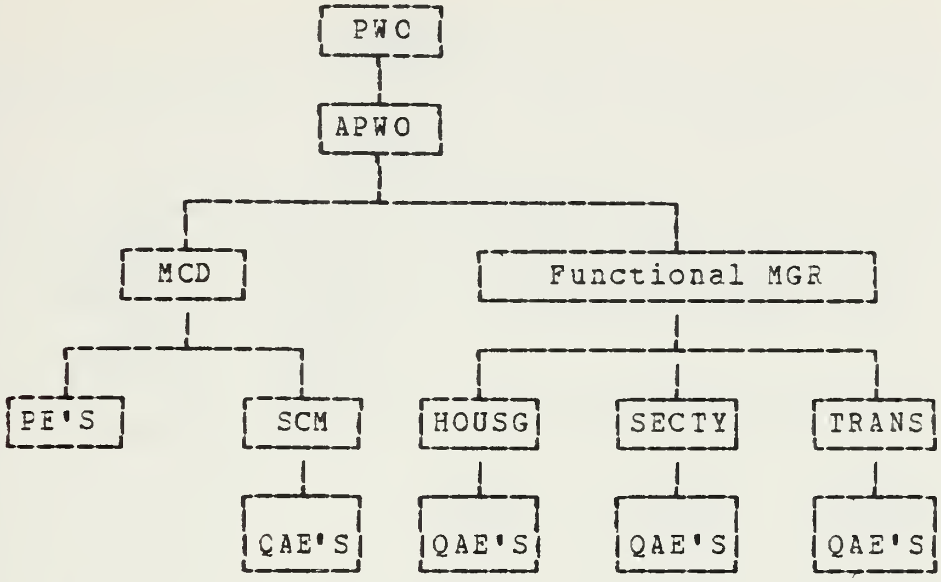
Figure G.1 Centralized Organization With SCM as Manager.



Legend: Same as Figure 1

The FSC Office is centralized, but located within the activity's Maintenance Control Division.

Figure G.2 Centralized Organization Located in MCD.



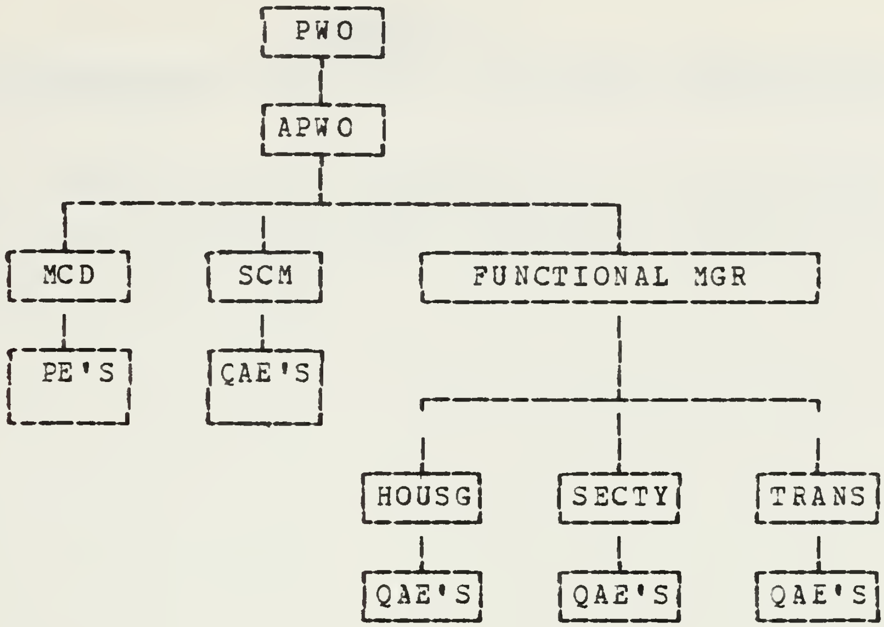
Legend

Identical to Figure 1; additionally:

HOUSG = Housing Division
SECTY = Security Division
TRANS = Transportation Division

SCM's supervise a limited number of (or no) QAE's. QAE's primarily work for functional managers. SCM functions more as an advisor.

Figure G.3 Decentralized System With SCM in MCD.



Legend

Same as in Figures 1 and 3

In this organizational format, the SCM is a division head of the activity. Direct control of QAE's is exercised by functional managers. The SCM acts primarily in an advisory capacity.

Figure G.4 Decentralized System: FSC Office is a PWD Division.

APPENDIX H

AFLC SUPPLEMENTARY POLICY FOR QAE BRANCH ORGANIZATION

In this Appendix, AFLC Supplement No. 1 is provided. It illustrates amplifying Air Force Logistics Command Guidance which pertains to AFR 70-9.

DEPARTMENT OF THE AIR FORCE
Headquarters Air Force Logistics Command
Wright-Patterson Air Force Base OH 45433

AFLC SUPPLEMENT 1
AFR 70-9
26 February 1982

Contracting and Acquisition

BASE LEVEL CONTRACT ADMINISTRATION

AFR 70-9, 25 September 1979, is supplemented as follows:

1c. Where separate contract administration offices exist, the term "BCO" in the basic regulation is interpreted as "ACO," except in paragraphs 1c and 8d.

6a. AFLC/PMM is OPR for the QAE program within AFLC.

6b. All QAEs will attend a phase I QAE training program, managed by the local QAE program coordinator, 30 days before the date of initial contract performance. If the training can't be completed 30 days before contract start, the contract file will contain the documented reason why the training couldn't be done within the specified time. Send a copy of the documentation to the functional area chief (FAC). The training program will be divided into two phases: The administrative contracting officer (ACO) is responsible for phase I training, which is basically an orientation. It covers provisions of individual contracts over which the QAE will have surveillance responsibility. Phase II training will be conducted using information and materials supplied by HQ USAF/RDCL, and will be completed at the first quarterly training session ofter appointment. This training is applicable to all contracts. The QAE program coordinator will give the Civilian Personnel Office a list of names of all the people who have sucessfull completed the Air Force-prepared training course. The Civilian Personnel Training Office will:

(1) Authenticate completion of the training on DD Form 1556, Request, Authorization, Agreement, Certification of Training and Reimbursement.

(2) Place a copy of DD Form 1556 in the individual's official personnel folder.

(3) Give a copy to the individual, the QAE program coordinator, and the cognizant FAC.

(4) Keep records on file for persons completing this training.

7b. Upon receipt of Letters of Nomination from the FAC, the commander will appoint QAEs and their alternates in writing. A sufficient number of QAEs will be appointed to make sure adequate surveillance is provided at all times.

8d. Give copies of the letter of appointment to the contracting officer, along with the purchase request for recurring contract requirements. If a cost study is being conducted, furnish the letter of appointment as soon as the QAE is selected. The FAC will send a copy of the letter to the QAE program coordinator and the servicing Civilian Personnel Office. The Civilian Personnel Office will make sure AF Form 1378, Civilian Personnel Position Description, reflects duties of employees named as the QAE and alternate QAE.

8j. Develop surveillance plans (SP) for those contracts that don't have standard Performance Work Statements (PWS) to ensure proper contract surveillance. The contracting officer, FAC, and QAE should jointly prepare SPs and revisions to them and should tailor them to the individual contract. The frequency of QAE surveillance and the type of inspection (for example, random sampling, 100 percent inspection, surveillance check-list) for each surveillance area should be specified. Do this before the contract start date. If experience with the contractor shows that extensive surveillance isn't required, the SP may be revised to reduce the level of frequency of surveillance. Any revisions to SP require the concurrence of the contracting officer. Where SPs take the form of checklists, attach them to the AF Form 372, Contract Monitoring and Surveillamce Report, and submit to the contracting officer according to paragraph 10c.

9d. The ACO with the help of the QAE program coordinator, will:

(1) Give guidance to the FAC and QAE as appropriate regarding contract interpretation, resolution of problems, requirements of this regulation, and other related contracting matters.

Supersedes AFR 70-9/AFLC Sup 1, 5 May 1978.
No of printed pages: 3
OPR: PMM (W. Ely)
Approved by: Col Paul Baldasari
Writer-Editor: C. Rainey
Distribution: F;X (HQ USAF/LGP; HQ AFISC/DAP; AUL/SE..........1 ea)

(2) Indoctrinate the QAE and alternate QAE as to the extent of authority, responsibility, and limitation, as outlined in the contract and this regulation. Do this prior to contractor performance.

9e. Provide copies of contracts and contract modifications to the cognizant QAE, as well as the FAC, prior to service start dates.

9g. If the AFO and FAC agree that a quarterly meeting isn't required, document the contract file. When quarterly meetings are held, personnel attending will include as a minimum the contracting officer, QAE program coordinator, the FAC, and the QAE.

9h. Furnish the QAE with a information copy of correspondence pertaining to contract requirements or discrepancies sent to or received from the contractor.

9k(Added). The local QAE program coordinator is the focal point for the QAE program. The QAE program coordinator will keep a record of all contracts requiring QAEs, and the names and training records of QAEs appointed. The QAE program coordinator may be required periodically to provide information on the QAE program to HQ AFLC/PMM. Any reporting requirements developed in support of the QAE program will comply with AFR 178-7, as supplemented. The QAE program coordinator will work closely with cognizant contracting officers in making sure QAEs understand the responsibilities and the surveillance of specific contracts. The QAE program coordinator will make sure records are maintained of the conferences held according to paragraph 9g.

10b. The Chief QAE is responsible for certification of contractor invoices that services were satisfactory.

10c. The QAE will maintain appropriate forms (AF Form 802, Contract Discrepancy Report; AF Form 799, Surveillance Activity Checklist) for each contract. The use of AFLC Form 134, TRCO Daily Log, is authorized only until the present supply of the form is exhausted, or until new contracts go into effect. AFLC Form 134 is not authorized for contracts awarded after date of this publication. Type entries or record them legibly in ink:

(1) Enter and sign on the forms, as required by the contracting officer for services performed, a notation of the contractor's performance including any deficiencies. For services performed on other than a daily basis, enter and sign the notation when the contractor actually performs the services. Annotate this only when the QAE performs an inspection.

(2) Record any performance deficiencies noted in precise, descriptive language. Notify the contractor's project manager (or authorized representative) and request acknowledgement by concurrence or nonconcurrence in the Remarks section of the forms that the deficiency does exist. If the contractor concurs, a statement is required outlining actions planned or taken to correct the deficiency and prevent its recurrence. In cases of contractor nonconcurrence, the QAE should immediately contact the contracting officer. If the contractor's project manager (or authorized representative) isn't available to discuss the discrepancies, notify the contracting officer who, in turn, notifies the contractor (by letter if time permits) of the deficiencies. When prompt corrective action isn't taken or when a deficiency becomes more serious, notify the contracting officer and the FAC. Document the notification by annotating the AF Form 802.

(3) Hand-carry, when feasible, the QAE reports for the previous month (assembled and sequentially numbered) to the contracting officer by the 5th workday of each month, or more often if deemed necessary by the contracting officer. The contracting officer will review and initial the QAE reports and will then place the reports in the official contract file unless the contracting officer determines that the QAE should keep the reports. In that case, the reports are furnished to the contracting officer for inclusion in the contract file upon contract completion.

10e(Added). Limitations of Authority. QAE personnel will not:

(1) Clarify, make, or infer legal interpretations on the scope or intent of the contract.

(2) Approve contractor procedures unless specifically provided by the terms and conditions of the contract. When contractually authorized, approval authority remains subject to any limitations the contracting officer may impose.

(3) Authorize expenditure of funds, except under the specific terms of the contract.

(4) Levy or impose upon contractors any task or permit any substitution not specifically provided for in the contract.

(5) Enter into contractual agreements including contract modifications.

(6) Give direction to the contractor or to employees of the contractor.

(7) Offer advice to the contractor which may adversely affect contract performance, compromise the rights of the Government, provide the basis of a claim for constructive change, or impact any pending or future contracting officer determinations as to fault or negligence.

11. Waivers to the requirements of this paragraph will be in writing, signed by the FAC. Send copies to the QAE program coordinator and the contracting officer.

12. Send all requests for deviations to HQ AFLC/PMM.

OFFICIAL

JAMES P. MULLINS, General, USAF
Commander

WILLIAM R. CARROLL, Colonel, USAF
Director of Administration

APPENDIX I

ABBREVIATIONS USED IN THE STUDY TEXT

Abbreviation	Description
A-76	OMB Circular A-76
AFR	Air Force Regulation
AFSCAG	Air Force Service Contract Advisory Group
AFLC	Air Force Logistics Command
AQL	Acceptable quality level
ASBCA	Armed Services Board of Contract Appeals
BOB	Bureau of the Budget
BOS	Base Operating Support
CA	Commercial Activities
CNM	Chief of Navy Material
CNO	Chief of Navy Operations
DOD	Department of Defense
EFD	Engineering Field Division
FY	Fiscal Year
GAO	General Accounting Office
GS	General Schedule Series
LANTDIV	Atlantic Division, NAVFAC
MCD	Maintenance Control Division
MEO	Most Efficient Organization
MIL-STD-105D	Military Standard 105D
NAVFAC	Naval Facilities Engineering Command
NAVSUP	Naval Supply Systems Command
NORTHDIV	Northern Division, NAVFAC
NRCC	Navy Regional Contracting Center
NSC	Naval Supply Center
OFPP	Office of Federal Procurement Policy
OMB	Office of Management and Budget

ONR	Office of Naval Research
PRS	Performance Requirements Summary
PWC	Public Works Center
PWD	Public Works Department
PWS	Performance Work Statement
QAE	Quality Assurance Evaluator
SQC	Statistical Quality Control
SCM	Service Contract Manager
SOUTHDIV	Southern Division, NAVFAC

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